

Chronic Diseases and Injuries in Canada

Volume 33 • Number 3 • June 2013

Inside this issue

- 113 The economic burden of traumatic spinal cord injury in Canada
- 123 Quantifying Canadians' use of the Internet as a source of information on behavioural risk factor modifications related to cancer prevention
- 129 Emergency department presentations for injuries associated with inflatable amusement structures, Canada, 1990–2009
- 137 Evolution of the determinants of chronic liver disease in Quebec
- 146 Deprivation and food access and balance in Saskatoon, Saskatchewan
- 160 Identifying cases of congestive heart failure from administrative data: a validation study using primary care patient records
- 167 Pain and health-related quality of life in people with chronic leg ulcers
- 175 Injuries related to consumer products in Canada—a systematic literature review
- 188 Cross-Canada Forum – National Population Health Study of Neurological Conditions in Canada
- 192 Status Report – Enhancing the Canadian Best Practices Portal
- 194 Release notice: Canadian Cancer Statistics 2013



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Canada

Chronic Diseases and Injuries in Canada

a publication of the Public Health Agency
of Canada

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Ottawa, Ontario K1A 0K9

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Indexed in Index Medicus/MEDLINE,
SciSearch® and Journal Citation Reports/
Science Edition

To promote and protect the health of Canadians through leadership, partnership, innovation and action in public health.
— Public Health Agency of Canada

Published by authority of the Minister of Health.

© Her Majesty the Queen in Right of Canada, represented by the Minister of Health, 2013
ISSN 1925-6515
Pub. 130025

This publication is also available online at www.publichealth.gc.ca/cdic
Également disponible en français sous le titre : *Maladies chroniques et blessures au Canada*

The economic burden of traumatic spinal cord injury in Canada

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This article has been peer reviewed.

Abstract

Introduction: The purpose of this study is to estimate the current lifetime economic burden of traumatic spinal cord injury (tSCI) in Canada from a societal perspective, including both direct and indirect costs, using an incidence-based approach.

Methods: Available resource use and cost information for complete/incomplete tetraplegia and paraplegia was applied to the estimated annual incidence of tSCI, by severity, in Canada.

Results: The estimated lifetime economic burden per individual with tSCI ranges from \$1.5 million for incomplete paraplegia to \$3.0 million for complete tetraplegia. The annual economic burden associated with 1389 new persons with tSCI surviving their initial hospitalization is estimated at \$2.67 billion.

Conclusion: While the number of injuries per year in Canada is relatively small, the annual economic burden is substantial.

Keywords: traumatic spinal cord injury, economic burden, morbidity, mortality

Introduction

Traumatic spinal cord injuries (tSCI) exact an extensive burden on the injured individual, their family and carers, and society as a whole. In addition to the physical and psychosocial trauma, the economic burden is thought to be substantial, due to increased health care costs as well as higher rates of morbidity and premature mortality. Information on the lifetime economic burden following a tSCI, however, is limited, especially in Canada.

Existing literature on the costs of tSCI tends to focus on subgroups of tSCI patients (e.g. veterans,^{1,2} those admitted to the United States Spinal Cord Injuries Model Systems hospitals,^{3,4,5} and work-related injuries⁶), a particular aspect of the economic burden (e.g. rehabilitation and unplanned hospitalizations^{7,8}) or a specific time frame following the tSCI.⁹

Two research groups, one in Canada^{9,10,11} and the other in the United States,^{12,13} have taken a population-based approach. The study from Alberta collected direct cost information for the first six years following a tSCI;^{9,10,11} the U.S. study considered lifetime direct and indirect costs, but these are from 1988 and need to be updated. Direct costs tend to include injury-related expenditures by the health care system and by the patient and/or the caregiver(s).^{12,13} Indirect costs "refer to the value of potential output that is lost as a result of any reduction or elimination of work or other activity due to SCI. These costs are measured as the losses that occur due to the reduction in productivity that results from morbidity or mortality attributable to SCI."^{12,p12}

Both the Alberta and the U.S. studies found that a population-based approach yielded a significantly different mix of

patients when compared with an institution-based approach.^{10,12} That is, individuals with tSCI cared for by the U.S. Model System, for example, tend to have, on average, much more severe injuries compared with the general population of patients with tSCI.¹² This difference can have an important effect on estimating the economic burden of tSCI.

Further, as most of the existing literature is from the U.S. and differences between the U.S. and Canadian health care systems make comparison difficult, there is a need for research on costs from a Canadian perspective.

This study uses the best information available in the literature to model the current lifetime economic burden of tSCI in Canada based on a societal perspective.

Methods

We used data from a variety of published sources to develop a model of the lifetime economic burden of tSCI by injury severity. Whenever possible, we used data from Canadian population-based studies.^{9,10,11} These were largely supplemented by data from the two U.S. population-based studies, one published in 1992^{12,13} and the other in 1998¹⁴ (see Table 1). Costs based on the Canadian study were adjusted to 2011 dollars based on the Health and Personal Care (HPC) component of the Canadian Consumer Price Index (CPI).¹⁵ U.S. costs were adjusted to 2011 Canadian dollars by first converting them into equivalent Canadian dollars for the given year and then increasing them to 2011 Canadian dollars as above.

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TABLE 1
Base model assumptions

Area of Focus	Values used				Sensitivity analysis	Source
	Tetraplegia		Paraplegia			
	Complete	Incomplete	Complete	Incomplete		
Direct Costs						
Initial hospitalization (acute and rehab)						
ALOS, days	153.0	49.0	123.0	42.2		Dryden et al. (2005) ⁹
Cost, \$	158 049	46 760	109 418	42 609		Dryden et al. (2005) ⁹
Number of physician services	53	16	38	15		Dryden et al. (2005) ⁹
Cost, \$	10 989	3156	7131	3551		Dryden et al. (2005) ⁹
Subsequent hospitalizations in year 1						
Average number of admissions	0.30	0.31	0.26	0.23		Dryden et al. (2004) ¹¹
ALOS per admission, days	10.1	8.6	8.7	5.2		Dryden et al. (2004) ¹¹
Cost per acute care day, \$	1124	1124	1124	1124		Ontario Case Costing Initiative
Cost, \$	3416	3036	2545	1321		Calculated
Subsequent annual hospitalizations						
Average number of admissions	0.30	0.31	0.26	0.23	+/- 25%	Dryden et al. (2004) ¹¹
ALOS per admission, days	10.1	8.6	8.7	5.2	+/- 25%	Dryden et al. (2004) ¹¹
Cost per acute care day, \$	1124	1124	1124	1124		Ontario Case Costing Initiative ¹⁶
Cost, \$	3416	3036	2545	1321		Calculated
Annual HCP						
Number of physician visits	27.9	19.9	20.3	15.4	+/- 25%	Harvey et al. (1992) ¹³
Number of non-physician visits ^c	88.1	82.1	34.3	17.8	+/- 25%	Harvey et al. (1992) ¹³
Cost per visit, \$	64.31	63.80	71.33	77.81	+/- 25%	Calculated
Cost, \$	7460	6507	3895	2583		Berkowitz et al. (1992) ¹²
Home modifications						
One-time cost, \$						
Current residence	31 149	29 015	24 540	25 492		Berkowitz et al. (1998) ¹⁴
Other residence ^b	9610	8912	9973	9701		Berkowitz et al. (1998) ¹⁴
Annual Costs, \$						
Prescription drugs	791	308	278	538		Berkowitz et al. (1992) ¹²
Non-prescription items ^c	4867	4029	3376	2619		Berkowitz et al. (1992) ¹²
Adaptive equipment (< 5 years) ^d	9724	6261	4890	3147		Harvey et al. (1992) ¹³
Adaptive equipment (> 5 years) ^d	3695	2548	1578	885		Harvey et al. (1992) ¹³
Vehicle modifications	1015	1015	1015	1015		Berkowitz et al. (1998) ¹⁴
Annual institutional care						
% of SCI population in institutions	10.1	3.7	2.1	0.7		Berkowitz et al. (1992) ¹²
Cost, \$	1729.4	467.4	347.1	104.5		Berkowitz et al. (1992) ¹²
Annual attendant care						
Hours per week	56.3	31.9	13.5	16.9	+/- 25%	Berkowitz et al. (1992) ¹²
Hours per year	2928	1659	702	879		Calculated
% of hours paid for ^e	50	50	41	18		Berkowitz et al. (1992) ¹²
Estimated cost per hour ^f , \$	17.52	17.52	17.52	17.52	+/- 25%	Statistics Canada ¹⁸
Cost ^f , \$	51 292	29 062	12 299	15 397		Calculated
Indirect costs						
% early deaths (between injury and initial hospital discharge)	27.8		13.3			Dryden et al. (2003) ¹⁰
Disability weighting	0.45	0.45	0.45	0.45	0.75, 0.65, 0.55, 0.45	Andresen et al. (1999) ²⁰

Continued on the following page

TABLE 1 (continued)
Base model assumptions

Area of Focus	Values used				Sensitivity analysis	Source
	Tetraplegia		Paraplegia			
	Complete	Incomplete	Complete	Incomplete		
Life years lost (35-year-old SCI survivor)	19.05	5.70	12.50	5.70	25–45 year old SCI survivor	NSCISC Annual Statistical Report, 2009 ²¹
Value of a saved life year ^d , \$	47 834	47 834	47 834	47 834		Statistics Canada Survey of Labour, Income & Dynamics ¹⁹
% of surviving SCI population	7.7	46.8	11.7	33.8		Dryden et al. (2005) ⁹
Discount rate	2.0	2.0	2.0	2.0	0%–4.0%	

Abbreviations: ALOS, average length of stay; CPI, Consumer Price index; HPC, health and personal care; HCP, health care practitioner; SCI, spinal cord injury.

^a Physiotherapists, occupational therapists, psychologists, nurses, chiropractors, etc.

^b Includes other homes owned by the SCI survivor as well as modifications to homes of family and friends specifically to accommodate the person with SCI.

^c Includes non-prescription pain medication, catheters, dressings and bandages, laxatives, vitamins, rubber gloves, etc.¹²

^d Includes breathing / handling aides (e.g. ventilators, head pointers, mouth sticks, etc.), mobility aids (e.g. wheelchairs, braces, crutches, etc.), bed / hygiene aids (e.g. hospital beds, special mattresses, bed or bath lifts, commode seats, etc.) and exercise and other miscellaneous items (e.g. exercise bikes, weights, special telephones, etc.)

^e A proportion of the hours worked for which the person providing the service received remuneration.

^f Based on the median Canadian hourly wage for "Assisting Occupations in Support of Health Services", 2005 value of \$15.669 adjusted to 2011 using the HPC component of the CPI (+11.8%).¹⁸

^g Based on the median Canadian earnings of full-year full-time workers, 2009 value of \$45,600 (Survey of Labour, Income and Dynamics) adjusted to 2011 using the CPI (+4.9%).¹⁹

Direct costs

We derived costs associated with initial hospitalization from the work by Dryden et al.⁹ in Alberta.

We calculated the cost per acute care day for hospitalizations following the initial hospitalization based on costs from the Ontario Case Costing Initiative¹⁶ using a mix of in-patient admissions for diseases of the genitourinary system (47%), skin and subcutaneous tissue (35%) and the respiratory system (18%).¹⁷ This approach was used because the majority of hospitalizations after an initial injury are for these three complications. We then applied the cost per acute care developed in this fashion in valuing all acute hospitalizations, including those for depression, substance abuse, etc.

Visits to non-physicians included services provided by physiotherapists, occupational therapists, psychologists, nurses, chiropractors, etc.¹³ Home modifications included all those designed specifically to accommodate the person with SCI in both the principal and any secondary homes, in addition to the homes of family and friends.¹⁴ Non-prescription items included non-prescription pain medication, cathe-

ters, dressings and bandages, laxatives, vitamins and rubber gloves.¹² Adaptive equipment includes breathing/handling aides (e.g. ventilators), mobility aids (e.g. wheelchairs, braces, crutches), bed/hygiene aids (e.g. hospital beds, special mattresses, bed or bath lifts, commode seats) and exercise and other miscellaneous items (e.g. exercise bikes, weights, special telephones).¹³

The cost per hour for attendant care was based on the median Canadian hourly wage for "Assisting Occupations in Support of Health Services."¹⁸

Indirect costs

We used a modified human-capital approach (in which unpaid time is explicitly valued) to calculate indirect costs; in this way, a quality-adjusted life year (QALY) was valued at \$47 834 (the average Canadian annual wage rate in 2011)¹⁹ regardless of the individual's age or work status. Life years lost were quality-adjusted based on a utility of 0.45, which has been reported for persons with SCI.²⁰ Thus, one year of life with an SCI would receive a value of 0.45 QALYs. The loss of 0.55 QALYs was thus valued at \$26 309 (0.55 × \$47 834). In this way,

indirect costs would accumulate post-injury for persons living with SCI.

Life years lost associated with an SCI were based on the age and life expectancy based on injury severity derived from the 2009 National Spinal Cord Injury Statistical Center (NSCISC) Annual Statistical Report²¹ and adjusted for differences in the life expectancy of the Canadian population.²² That is, individuals with an SCI die sooner than if they did not have that injury, with the number of life years lost increasing with the severity of the injury. Each of these life years lost were assigned a value of \$47 834.

The economic burden of tSCI in Canada was developed using an incidence-based approach. "An incidence-based approach measures the (lifetime) costs associated with all new injuries occurring within a given period (usually a year), while a prevalence-based approach measures costs incurred by all SCI individuals alive in a given period."^{12,p14} We took the annual incidence of tSCI surviving hospitalization in Canada (1389) from Noonan et al.,²³ and derived the distribution of injury severity (106 [7.7%] with complete tetraplegia, 651 [46.8%] with incomplete tetraplegia, 163 [11.7%] with complete

paraplegia and 469 [33.8%] with incomplete paraplegia) from Dryden et al.¹⁰

All costs were discounted at an annual rate of 2%. The discount rate "is the rate at which we devalue the costs incurring into the future."^{12,p168} This rate was varied from 0% to 4% in the sensitivity analysis.

Sensitivity analysis is frequently used in economic studies to vary key assumptions and determine if these changes have an important effect on the overall results. In this study, we applied sensitivity analyses to the major cost drivers including age at injury, disability weighting, discount rate, hospital admissions, health care practitioner (HCP) visits and attendant care (see Table 1).

Results

The estimated lifetime economic burden associated with a tSCI in Canada ranges from \$1.47 million for a person with incomplete paraplegia to \$3.03 million for one with complete tetraplegia (see Table 2). Of the total costs, direct costs represent between 44% and 51% in patients with paraplegia and between 56% and 66% in patients with tetraplegia. Within direct costs, the most significant cost driver was the cost of attendant care following the injury. These costs alone ranged from \$0.29 million to \$1.02 million (38%–60% of direct costs). Hospitalization costs ranged from \$0.08 million to \$0.23 million (5%–13% of direct costs) while HCP costs ranged from

\$0.07 million to \$0.15 million (10%–13% of direct costs).

The estimated annual economic burden associated with tSCI in Canada is \$2.67 billion (\$1.57 billion in direct costs and \$1.10 billion in indirect costs; see Table 3). Costs associated with hospitalizations (\$0.17 billion or 6.5% of total costs), HCP visits (\$0.18 billion or 6.7%), equipment and home modifications (\$0.31 billion or 11.6%) and attendant care (\$0.87 billion or 32.7%) are the major direct cost drivers.

The results of the sensitivity analyses are summarized in Table 4. Costs are most sensitive to the choice of discount rate. Excluding any discounting (an effective

TABLE 2
Lifetime economic burden associated with spinal cord injury

Injury occurring at age 35 years								
2011 Canadian dollars, 2% Discount Rate								
	Tetraplegia				Paraplegia			
	Complete		Incomplete		Complete		Incomplete	
	\$ Value	% of Total	\$ Value	% of Total	\$ Value	% of Total	\$ Value	% of Total
Direct costs								
Health care								
Hospitalization	226 137	7.5	130 139	6.2	170 385	9.6	78 900	5.4
HCP	152 231	5.0	175 368	8.3	96 543	5.4	71 914	4.9
Prescription drugs	15 747	0.5	8443	0.4	18 929	1.1	8443	0.6
Subtotal health care	394 115	13.0	313 951	14.9	285 857	16.0	159 256	10.8
Equipment and modifications								
Non-prescription items	96 917	3.2	110 565	5.3	80 815	4.5	71 870	4.9
Adaptive equipment	102 921	3.4	88 014	4.2	53 840	3.0	35 257	2.4
Home modifications	40 759	1.3	37 927	1.8	34 513	1.9	35 193	2.4
Vehicle modifications	20 203	0.7	27 842	1.3	24 285	1.4	27 842	1.9
Subtotal equipment and modifications	260 801	8.6	264 348	12.6	193 453	10.9	170 162	11.6
Long-term care								
Institutional care	34 439	1.1	12 826	0.6	8308	0.5	2868	0.2
Attendant care	1 021 420	33.8	797 590	37.9	294 418	16.5	422 548	28.7
Subtotal long-term care	1 055 859	34.9	810 417	38.5	302 726	17.0	425 416	28.9
Total direct costs	1 710 776	56.5	1 388 715	65.9	782 036	43.9	754 835	51.3
Indirect costs								
Morbidity	428 655	14.2	590 746	28.1	515 279	28.9	590 746	40.1
Premature mortality	886 597	29.3	126 350	6.0	485 384	27.2	126 350	8.6
Total indirect costs	1 315 252	43.5	717 096	34.1	1 000 662	56.1	717 096	48.7
Overall total	3 026 028	100.0	2 105 811	100.0	1 782 698	100.0	1 471 931	100.0

Abbreviation: HCP, health care practitioner.

TABLE 3
Annual economic burden associated with spinal cord injury in Canada

	Injury occurring at age 35 years					
	2011 Canadian dollars, 2% Discount Rate					
	Tetraplegia		Paraplegia			
	Complete	Incomplete	Complete	Incomplete	Total	% of Total
Number of surviving incident cases ^a	106	651	163	469	1389	
Direct costs (in millions), \$						
Health care						
Hospitalization	24.1	84.7	27.7	37.0	173.5	6.5
HCP	16.2	114.1	15.7	33.7	179.8	6.7
Prescription drugs	1.7	5.5	3.1	4.0	14.2	0.5
Subtotal health care	41.9	204.3	46.5	74.7	367.4	13.7
Equipment and modifications						
Non-prescription items	10.3	71.9	13.1	33.7	129.1	4.8
Adaptive equipment	10.9	57.3	8.8	16.5	93.5	3.5
Home modifications	4.3	24.7	5.6	16.5	51.1	1.9
Vehicle modifications	2.1	18.1	4.0	13.1	37.3	1.4
Subtotal equipment and modifications	27.7	172.0	31.5	79.8	311.1	11.6
Long-term care						
Institutional care	3.7	8.3	1.4	1.3	14.7	0.6
Attendant care	108.6	519.0	47.9	198.3	873.8	32.7
Subtotal long-term care	112.3	527.3	49.2	199.6	888.5	33.2
Total direct costs, \$	182.0	903.6	127.2	354.2	1567.0	58.6
Indirect costs, \$						
Morbidity	45.6	384.4	83.8	277.2	791.0	29.6
Premature mortality	94.3	82.2	79.0	59.3	314.8	11.8
Total indirect costs, \$	139.9	466.6	162.8	336.5	1105.8	41.4
Overall total, \$	321.9	1370.3	290.0	690.7	2672.8	100.0

Abbreviation: HCP, health care provider.

^a 1389 patients per year survive to be discharged following their initial hospitalization.²³

rate of 0%) increases the lifetime economic burden by 38% to 47%. Using a discount rate of 4% (compared to the base case discount rate of 2%) decreases the lifetime economic burden by 23% to 27%. The age at which the injury is sustained also has a significant effect. Using an average age of 25 years (compared to the base case assumption of 35 years) increases overall costs by 10% to 14% while using age 45 years decreases overall costs by 14% to 18%. Varying the disability weighting from 0.45 for all injuries to 0.45, 0.55, 0.65 and 0.75 for incomplete paraplegia, incomplete tetraplegia, complete paraplegia and complete tetraplegia, respectively, increases indirect costs by 18% to 23%.

Direct care costs are most sensitive to assumptions regarding the hours of atten-

dant care received. Increasing the annual number of hours of care received per year or the average wage rate by 25% increases direct costs by 9% to 15%. If both the number of hours and the wage rate are increased by 25%, then direct costs would increase by 21% to 34%.

Discussion

To our knowledge, this is the first attempt to quantify the lifetime economic burden of tSCI in Canada. We have attempted to be as extensive as possible in the scope of the costs included.

The value of cost-of-illness studies has been questioned, particularly given the varied approaches and methodological limitations associated with this type of research.^{24,25,26} However, Segui-Gomez

and Mackenzie²⁷ note that a variety of metrics, including economic burden, are important when assessing the impact to society of injuries, particularly non-fatal injuries. Rice²⁸ notes that cost-of-illness studies "translate the adverse effects of diseases and injuries into dollar terms, the universal language of decision makers and the policy arena. These estimates are used to: (1) define the magnitude of the disease or injury in dollar terms; (2) justify intervention programs; (3) assist in the allocation of research dollars on specific diseases; (4) provide a basis for policy and planning relative to prevention and control initiatives; and (5) provide an economic framework for program evaluation."^{28,p178}

Unfortunately, the application of these studies to the policy arena continues to be problematic. For example, in 1995 the

TABLE 4
Lifetime economic burden associated with spinal cord injury

	Sensitivity analysis 2011 Canadian Dollars							
	Tetraplegia				Paraplegia			
	Complete, \$	% Change from Base	Incomplete, \$	% Change from Base	Complete, \$	% Change from Base	Incomplete, \$	% Change from Base
Base case								
Direct costs	1 710 775		1 388 715		782 036		754 834	
Indirect costs	1 315 251		717 096		1 000 662		717 096	
Total costs	3 026 027		2 105 811		1 782 698		1 471 930	
Discount rate (0%)								
Direct costs	2 089 080	22.1	1 931 791	39.1	990 747	26.7	1 035 128	37.1
Indirect costs	2 093 169	59.1	1 126 491	57.1	1 596 826	59.6	1 126 491	57.1
Total costs	4 182 249	38.2	3 058 282	45.2	2 587 573	45.1	2 161 619	46.9
Discount rate (4%)								
Direct costs	1 437 892	(16.0)	1 056 393	(23.9)	643 468	(17.7)	583 277	(22.7)
Indirect costs	890 518	(32.3)	495 242	(30.9)	679 325	(32.1)	495 243	(30.9)
Total costs	2 328 411	(23.1)	1 551 636	(26.3)	1 322 789	(25.8)	1 078 520	(26.7)
Average age (25 years)								
Direct costs	2 049 089	19.8	1 569 131	13.0	896 299	14.6	847 909	12.3
Indirect costs	1 399 792	6.4	775 979	8.2	1 065 542	6.5	775 979	8.2
Total costs	3 448 881	14.0	2 345 110	11.4	1 961 841	10.0	1 623 888	10.3
Average age (45 years)								
Direct costs	1 314 480	(23.2)	1 172 657	(15.6)	661 964	(15.4)	643 373	(14.8)
Indirect costs	1 175 364	(10.6)	618 796	(13.7)	874 421	(12.6)	618 796	(13.7)
Total costs	2 489 844	(17.7)	1 791 453	(14.9)	1 536 385	(13.8)	1 262 169	(14.3)
Disability weighting^a								
Direct costs	1 710 776	0.0	1 388 715	(0.0)	782 036	(0.0)	754 835	-
Indirect costs	1 601 022	21.7	848 373	18.3	1 229 675	22.9	717 096	-
Total costs	3 311 798	9.4	2 237 088	6.2	2 011 711	12.8	1 471 931	-
Attendant care hours or wage rate (+25%)								
Direct costs	1 966 131	14.9	1 588 113	14.4	855 641	9.4	860 472	14.0
Indirect costs	1 315 252	0.0	717 096	(0.0)	1 000 662	(0.0)	717 096	(0.0)
Total costs	3 281 383	8.4	2 305 209	9.5	1 856 303	4.1	1 577 568	7.2
Attendant care hours or wage rate (-25%)								
Direct costs	1 455 421	(14.9)	1 189 318	(14.4)	708 432	(9.4)	649 198	(14.0)
Indirect costs	1 315 252	0.0	717 096	(0.0)	1 000 662	(0.0)	717 096	(0.0)
Total costs	2 770 673	(8.4)	1 906 414	(9.5)	1 709 094	(4.1)	1 366 294	(7.2)
Attendant care hours and wage rate (+25%)								
Direct costs	2 285 324	33.6	1 837 360	32.3	947 646	21.2	992 518	31.5
Indirect costs	1 315 252	0.0	717 096	(0.0)	1 000 662	(0.0)	717 096	(0.0)
Total costs	3 600 576	19.0	2 554 456	21.3	1 948 308	9.3	1 709 614	16.1
Attendant care hours and wage rate (-25%)								
Direct costs	1 263 904	(26.1)	1 039 769	(25.1)	653 228	(16.5)	569 970	(24.5)
Indirect costs	1 315 252	0.0	717 096	(0.0)	1 000 662	(0.0)	717 096	(0.0)
Total costs	2 579 156	(14.8)	1 756 865	(16.6)	1 653 890	(7.2)	1 287 066	(12.6)
Annual number of hospital admissions or ALOS (+25%)								
Direct Costs	1 726 944	0.9	1 408 801	1.4	796 642	1.9	763 577	1.2

Continued on the following page

TABLE 4 (continued)
Lifetime economic burden associated with spinal cord injury

	Sensitivity analysis							
	2011 Canadian Dollars							
	Tetraplegia				Paraplegia			
	Complete, \$	% Change from Base	Incomplete, \$	% Change from Base	Complete, \$	% Change from Base	Incomplete, \$	% Change from Base
Indirect Costs	1 315 252	0.0	717 096	(0.0)	1 000 662	(0.0)	717 096	(0.0)
Total Costs	3 042 196	0.5	2 125 897	1.0	1 797 304	0.8	1 480 673	0.6
Annual number of hospital admissions or ALOS (-25%)								
Direct Costs	1 693 754	(1.0)	1 367 870	(1.5)	766 795	(1.9)	745 762	(1.2)
Indirect Costs	1 315 252	0.0	717 096	(0.0)	1 000 662	(0.0)	717 096	(0.0)
Total Costs	3 009 006	(0.6)	2 084 966	(1.0)	1 767 457	(0.9)	1 462 858	(0.6)
Annual number of hospital admissions and ALOS (+25%)								
Direct Costs	1 749 076	2.2	1 435 616	3.4	816 330	4.4	775 248	2.7
Indirect Costs	1 315 252	0.0	717 096	(0.0)	1 000 662	(0.0)	717 096	(0.0)
Total Costs	3 064 328	1.3	2 152 712	2.2	1 816 992	1.9	1 492 344	1.4
Annual number of hospital admissions and ALOS (-25%)								
Direct Costs	1 680 987	(1.7)	1 352 237	(2.6)	755 363	(3.4)	738 957	(2.1)
Indirect Costs	1 315 252	0.0	717 096	(0.0)	1 000 662	(0.0)	717 096	(0.0)
Total Costs	2 996 239	(1.0)	2 069 333	(1.7)	1 756 025	(1.5)	1 456 053	(1.1)
Annual number of or average cost per HCP visits (+25%)								
Direct Costs	1 746 086	2.1	1 431 768	3.1	804 389	2.9	771 925	2.3
Indirect Costs	1 315 252	0.0	717 096	(0.0)	1 000 662	(0.0)	717 096	(0.0)
Total Costs	3 061 338	1.2	2 148 864	2.0	1 805 051	1.3	1 489 021	1.2
Annual number of or average cost per HCP visits (-25%)								
Direct Costs	1 675 465	(2.1)	1 345 662	(3.1)	759 683	(2.9)	737 744	(2.3)
Indirect Costs	1 315 252	0.0	717 096	(0.0)	1 000 662	(0.0)	717 096	(0.0)
Total Costs	2 990 717	(1.2)	2 062 758	(2.0)	1 760 345	(1.3)	1 454 840	(1.2)
Annual number of and average cost per HCP visits (+25%)								
Direct Costs	1 790 225	4.6	1 485 584	7.0	832 330	6.4	793 289	5.1
Indirect Costs	1 315 252	0.0	717 096	(0.0)	1 000 662	(0.0)	717 096	(0.0)
Total Costs	3 105 477	2.6	2 202 680	4.6	1 832 992	2.8	1 510 385	2.6
Annual number of and average cost per HCP visits (-25%)								
Direct Costs	1 648 902	(3.6)	1 313 372	(5.4)	742 918	(5.0)	724 926	(4.0)
Indirect Costs	1 315 252	0.0	717 096	(0.0)	1 000 662	(0.0)	717 096	(0.0)
Total Costs	2 964 234	(2.0)	2 030 468	(3.6)	1 743 580	(2.2)	1 442 022	(2.0)

Abbreviations: ALOS, average length of stay; HCP, health care practitioner.

* Complete tetraplegia = 0.75; complete paraplegia = 0.65; incomplete tetraplegia = 0.55; incomplete paraplegia = 0.45.

U.S. Senate Committee on Appropriations recommended that the National Institutes of Health (NIH) produce a report on the societal cost of the diseases for which the NIH conducts and funds research.²⁸ A 1998 review by the U.S. Institute of Medicine recommended that the NIH strengthen its use of data on "disease burden and costs" in setting research funding priorities.²⁹ Despite producing disease-specific cost-of-illness reports in

1995, 1997 and 2000,²⁸ this information does not appear to be used in current research funding allocations by the NIH.^{30,31}

In an attempt to reduce the methodological heterogeneity of cost-of-illness studies while recognizing the "strong continuing demand for economic impact studies,"^{32,p2} associations such as the World Health Organization have proposed a

framework for conducting cost-of-illness studies "with a view to enhancing the consistency and coherence of economic impact studies in health."^{32,p3}

There are important limitations associated with this analysis. The analysis depends on published data from a variety of sources and timeframes rather than detailed costing of a patient cohort. Average costs also mask the wide varia-

tion in individual costs, even when accounting for the severity of the injury. As a result, these costs should not replace any professionally developed life care plan and the costs of implementing that care. In addition, no attempt was made to determine whether these costs are associated with optimal or even adequate care. In the U.S., Webster et al.⁶ found that "those with work-related tetraplegia may receive more injury-related paid medical benefits after the first year post-injury than cases who do not receive (workers compensation)-supported benefits."^{6,p240}

Estimating acute care costs is based on an aggregated disease-specific cost per patient day. An alternative approach would be to use Resource Intensity Weights assigned to each hospitalization together with an estimated cost per Resource Intensity Weight. The required information on specific hospitalizations, however, is currently unavailable but is something that the Rick Hansen Institute is in the process of addressing.

While an incidence-based approach to costing is nominally based on a trajectory of estimated life-time costs, in reality it requires an assumption (for this study) of functional status at a point in time. Actual changes in costs associated with changing functional status would only be possible given long-term, individual patient-level data.

The most commonly used method in valuing indirect costs is the human-capital approach. In this approach, gender- and age-specific average earnings are combined with productivity trends and years of life lost due to a specific disease/condition to estimate unrealized lifetime earnings. An important criticism of this method is that it places a higher value on the years of life lost for someone with higher earning potential (e.g. men aged 35–55 years) than someone with lower earning potential (e.g. women aged 75+ years).³⁵ In particular, unpaid work and leisure time are not explicitly accounted for in the human-capital approach.³⁴

In calculating indirect costs, we used a modified human-capital approach in which unpaid time is explicitly valued. This approach involved assigning a value

of \$47 834 (the average annual Canadian wage rate in 2011) to every QALY lost. The inclusion of valuing unpaid time within the human capital approach has been suggested by a number of researchers^{35,36} to address the inherent bias of the approach in undervaluing the impact of illness or injury in retired elderly people, the disabled and those who choose not to be gainfully employed.

Cao et al.⁴ recently estimated the value of average lifetime direct costs (versus charges) in the U.S. for an injury sustained at age 25 years and using a 2% discount rate. The range was from \$1.10 million (in 2009 U.S. dollars) for an American Spinal Injury Association (ASIA) Impairment Scale (AIS) D injury at any level to \$3.41 million for a C1–4 AIS A, B or C injury.⁴ Using the same major assumptions (injury at age 25 years, 2% discount rate), the present value of average lifetime direct costs derived from our analysis ranges from \$0.85 million to \$2.05 million, or approximately 23% to 40% lower than the U.S. estimate.

One possible reason for this difference is the higher overall cost of providing health care in the U.S. due to a combination of higher prices, administrative overhead costs, use of high-cost equipment and the practice of "defensive medicine" triggered by uniquely American tort laws. Excess costs in the U.S. are estimated to be approximately 40% over that of international comparators.³⁸

A further possibility for the disparity is the way in which attendant care is determined. DeVivo et al.⁵ estimated the annual hours of attendant care beginning in the second year following the injury to be from 1124 for an AIS D injury at any level to 5453 for a C1–4 A, B or C injury.⁵ Each paid or unpaid hour was valued at \$21.00 (in 2009 U.S. dollars). The annual number of hours appears to be derived "based on self-report of all persons in the NSCISC database who completed an annual follow up evaluation between 2000 and 2006 and had complete data on this item."^{5,p4} We used the considerably lower estimate (ranging from 702 to 2928 hours annually) from the Berkowitz et al.¹⁴ population-based study and applied a value of \$17.52 per hour for

both paid and unpaid hours. Comprehensive estimates of attendant care costs in the Canadian SCI population are needed, particularly because these costs are the single largest driver of direct costs.

Finally, it is important to note the difference when institution-based prevalence rather than population-based prevalence is used. In both the Canadian and U.S. population-based studies, the proportion of the SCI population with complete tetraplegia or paraplegia is similar, at 7% to 8% and 10% to 12%, respectively, whereas the prevalence of complete tetraplegia or paraplegia based on persons with SCI receiving care in the U.S. Model System tends to be substantially higher at 24% and 27%, respectively.^{10,12} This overweighting of more severe injuries is important to take into account, particularly when estimating the annual economic burden associated with tSCI.

To our knowledge, this is the first attempt to estimate the economic burden of tSCI in Canada. While the number of injuries per year is relatively small, the annual economic burden, at \$2.67 billion, is substantial. This burden could be reduced if some of the new cases could be avoided or if function could be improved³⁹ or secondary complications prevented (either through functional improvements or better management) after the tSCI occurs.

Acknowledgements

This study was funded by the Rick Hansen Institute and Health Canada.

Hans Krueger and Logan Trenaman received funding from the Rick Hansen Institute for this work. Vanessa Noonan, Phalgun Joshi, and Carly Rivers are employees of the Rick Hansen Institute.

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Quantifying Canadians' use of the Internet as a source of information on behavioural risk factor modifications related to cancer prevention

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This article has been peer reviewed.

Abstract

Introduction: The purpose of this study was to quantify the frequency and timing of Canadians' Internet searches for information on modifying cancer prevention-related behavioural risk factors.

Methods: We used the Google AdWords Keyword tool to estimate the number of Internet searches in Canada from July 2010 to May 2011 for content associated with the keywords "physical activity / exercise," "healthy eating / weight loss" and "quit smoking."

Results: For "physical activity / exercise," 663 related keywords resulted in 117 951 699 searches. For "healthy eating / weight loss," 687 related search terms yielded 98 277 954 searches. "Quit smoking" was associated with 759 related keywords with 31 688 973 searches. All search patterns noticeably peaked in January 2011.

Conclusion: Many Canadians are actively searching for information on the Internet to support health behaviour change associated with cancer prevention, especially during the month of January. To take advantage of this opportunity, key stakeholders in cancer prevention need to identify knowledge translation priorities and work with health agencies to develop evidence-based strategies to support Internet-facilitated behaviour change.

Keywords: cancer, prevention, Internet, weight loss, physical activity, smoking, healthy eating

Introduction

Tobacco use, alcohol use, overweight, an unhealthy diet and a sedentary lifestyle have been identified as the primary modifiable risk factors for cancer,^{1,2} and more than 30% of cancers could be avoided by making relevant lifestyle changes to avoid these risk factors.⁴ This potential for cancer prevention has led many health agencies to prioritize activities that contribute to starting and maintaining behaviour changes related to reducing tobacco use and exposure, reduc-

ing alcohol consumption, reducing overweight and obesity, improving diets and increasing physical activity.^{4,6}

One of the most common methods that members of the public use to look for current health-related information is through Internet searches.⁷ According to a Statistics Canada report, 80% of Canadians aged 16 years and older (21.7 million people) used the Internet for personal reasons in 2009, an 8% increase from 2007 and 12% increase from 2005.^{8,9} In addition, searches for information on specific diseases

or lifestyle factors increased by 11%, with 70% of Canadian home Internet users reporting that they use the Internet to search for health information, compared with 59% in 2007.^{8,9} Although this increase may be part of a general trend towards seeking information on the Internet, the widely publicized emergence of the H1N1 influenza strain as a global pandemic in June 2009¹⁰ may have contributed to this. The widespread use of the Internet by members of the public has led some health researchers to monitor changes in Internet-based information-seeking activity as a means of tracking changes in health behaviours, health status and public attitudes towards health promotional activities.¹¹

One of the first steps towards taking advantage of the opportunity to disseminate information to the public efficiently and effectively is to investigate the search patterns used by people seeking health information (i.e. timing of the searches and popular search terms used). Although there are many different search engines, the one developed and maintained by Google has come to dominate Internet searching for more than five years. Of the 137 billion estimated total searches performed in the United States in 2008, 85 billion used Google; similar numbers apply to searches conducted worldwide.¹² Google domains (i.e. google.ca and google.com) rank as the primary search engine in Canada, capturing 81% of the total volume of Canadian searches for the 12-week period ending July 2, 2011.¹³

The purpose of this study was to determine the frequency and timing of Internet

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searches for information on the following modifiable risk factors associated with cancer prevention: sedentary behaviour, being overweight and smoking.

Methods

We used the Google AdWords Keyword tool¹⁴ and Google Insight¹⁵ to get data on the frequency and timing of searches for three separate sets of search terms. The Keyword tool is a free online tool maintained by Google. After entering one or more search terms, the tool generates a list of all the Google-identified relevant keywords used to retrieve related information. The Keyword tool also provides average global and local search volumes associated with each term for the previous 12 months as well as the number of searches conducted each month for the past 11 months. The tool also allows users to narrow down the search for relevant keywords by country, language and category (e.g. health, business, etc.).

We conducted separate searches on July 14, 2011, for the period July 2010 to May 2011 for each of the following three English terms: "physical activity / exercise" (for sedentary behaviour), "healthy eating / weight loss" (for overweight and obesity) and "quit smoking" together with "Canada," "all languages" and "all categories." Three independent reviewers (C.R., L.H., C.G.) with expertise in public health and cancer prevention evaluated the keywords Google associated with each term and reached consensus on the terms to include in the frequency calculations. They deleted those terms that did not appear to be directly related to health behaviours associated with cancer prevention from the results. When there was doubt about a specific keyword, the term was entered directly into the Google search engine and the search results investigated. Because 90% of users only look for information in the first three pages of their Internet search results,¹⁶ we removed any search terms that did not

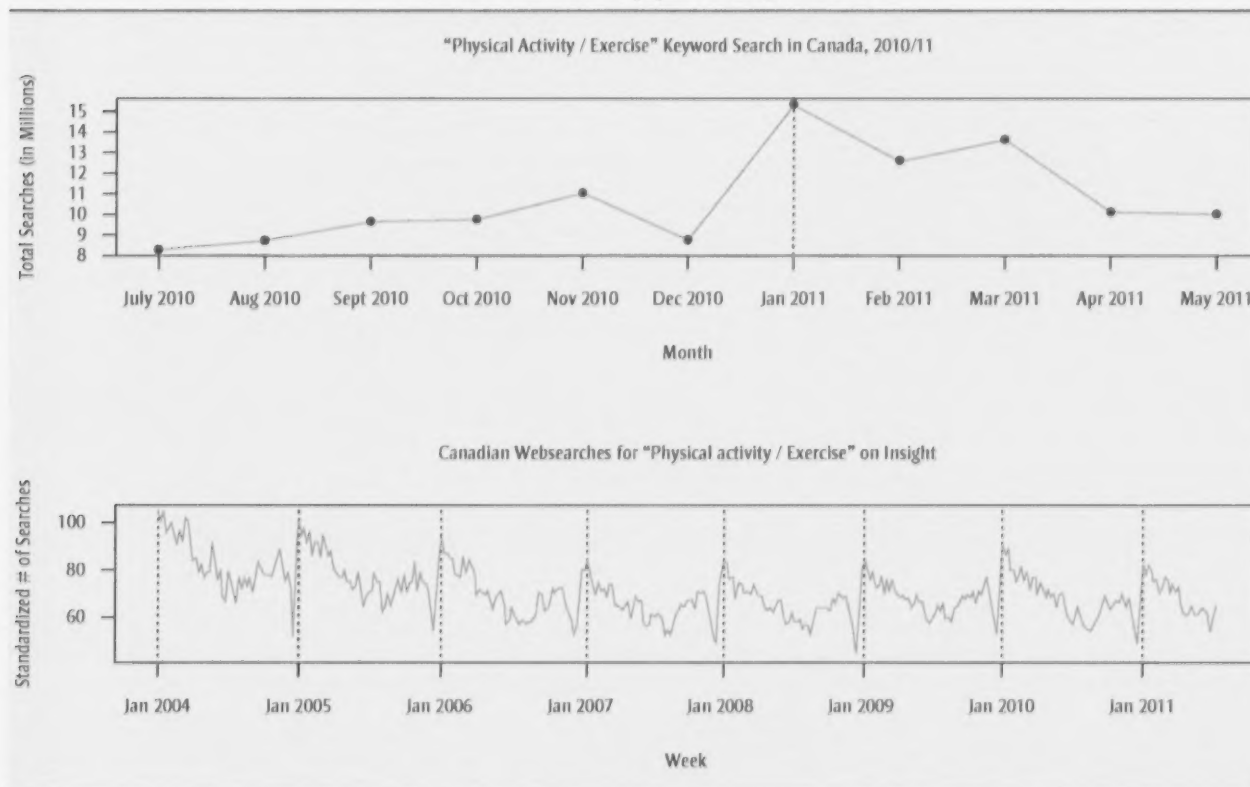
generate information about behaviours related to cancer prevention on the first three pages of the search results.

Google Insight also provided search trends from 2004 to 2011 for our three search terms. Google Insight characterizes the search volume patterns across regions, categories and time frames. Although the trends include searches for the main keywords, Google Insight does not provide absolute frequencies. Rather, the total number of monthly searches are standardized using the month with the highest number of searches as a reference (i.e. the frequency of searches for individual months are presented as a percentage of the month with the highest number of searches).¹⁷

Results

The Google AdWords Keywords search using the terms "physical activity / exercise" resulted in 799 unique terms.

FIGURE 1
Estimated number of monthly searches from July 2010 to May 2011 (top row) and search trends from January 2004 to January 2011 (bottom row) for the search term "physical activity / exercise"



After removing those not related to cancer prevention (e.g. "kegel exercises"), there remained 663 terms with a total of 117 951 699 searches over the 11-month period. The three most popular phrases were "LA Fitness" (a California-based fitness program with gyms in Canada and the United States; 17 620 000 searches), "how to exercise" (11 909 000 searches) and "why exercise" (11 909 000 searches). Monthly searches peaked in January 2011 (15 333 720 searches), accounting for 13% of all the searches in the study period, while the lowest number of searches took place in July 2010 (see Figure 1, top row). The results from the Google Insight search showed similar peaks in January every year between 2004 and 2011 (see Figure 1, bottom row).

The Google AdWords Keywords search using the terms "healthy eating / weight loss" resulted in 803 unique terms. After these were reviewed and unrelated terms eliminated (e.g. "dinner recipes" and

"diabetic diet"), there remained 687 search terms related to health behaviours associated with cancer prevention with 98 277 954 search queries for the 11-month period, July 2010 to May 2011. The three most popular keywords were "LA Weight Loss" (a California-based weight loss program; 15 868 000 searches), "weight loss" (7 934 000 searches) and "how to lose weight" (7 415 000 searches). The peak for all searches was 13.8%, in January 2011 (13 529 551 searches), while July 2010 had the fewest, at 6.8% (see Figure 2, top row). Google Insight showed a similar peak every January from 2004 to 2011. We also observed another distinctive peak during the week of May 23 to 29, 2010 (see Figure 2, bottom row).

The Google AdWords Keywords search using the keywords "quit smoking" yielded 793 unique search terms. Of these, we deleted 34 unrelated terms (e.g. "smoking weed"). The remaining 759

search terms yielded 31 688 973 search queries for the 11-month period. The three most popular search terms were "how to quit smoking" (842 500 searches), "why quit smoking" (842 500 searches) and "I quit smoking" (842 500 searches). The highest proportion of search traffic (13.5% of all the searches) was in January 2011 (see Figure 3, top row). Google Insight showed a similar peak in January of each year from 2004 to 2011 (see Figure 3, bottom row).

Discussion

The results of this study show that many Canadians search the Internet for information on modifying lifestyle factors that have been linked to cancer. Of our chosen search terms, "physical activity / exercise" (for sedentary behaviour) had the highest number of searches, followed by "healthy eating / weight loss" (for overweight/obesity) and "quit smoking." All these search terms showed temporal

FIGURE 2
Estimated number of monthly searches from July 2010 to May 2011 (top row) and search trend from January 2004 to January 2011 (bottom row) for the search term "healthy eating / weight loss"

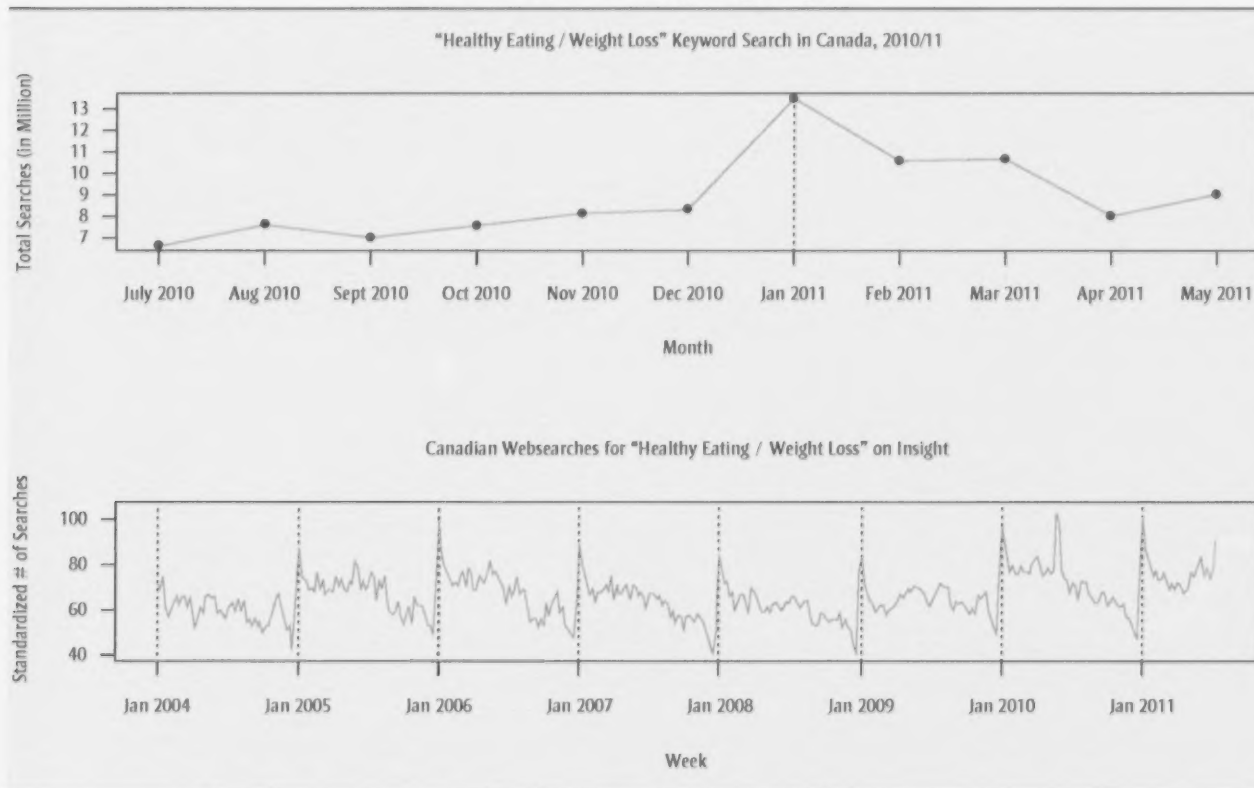
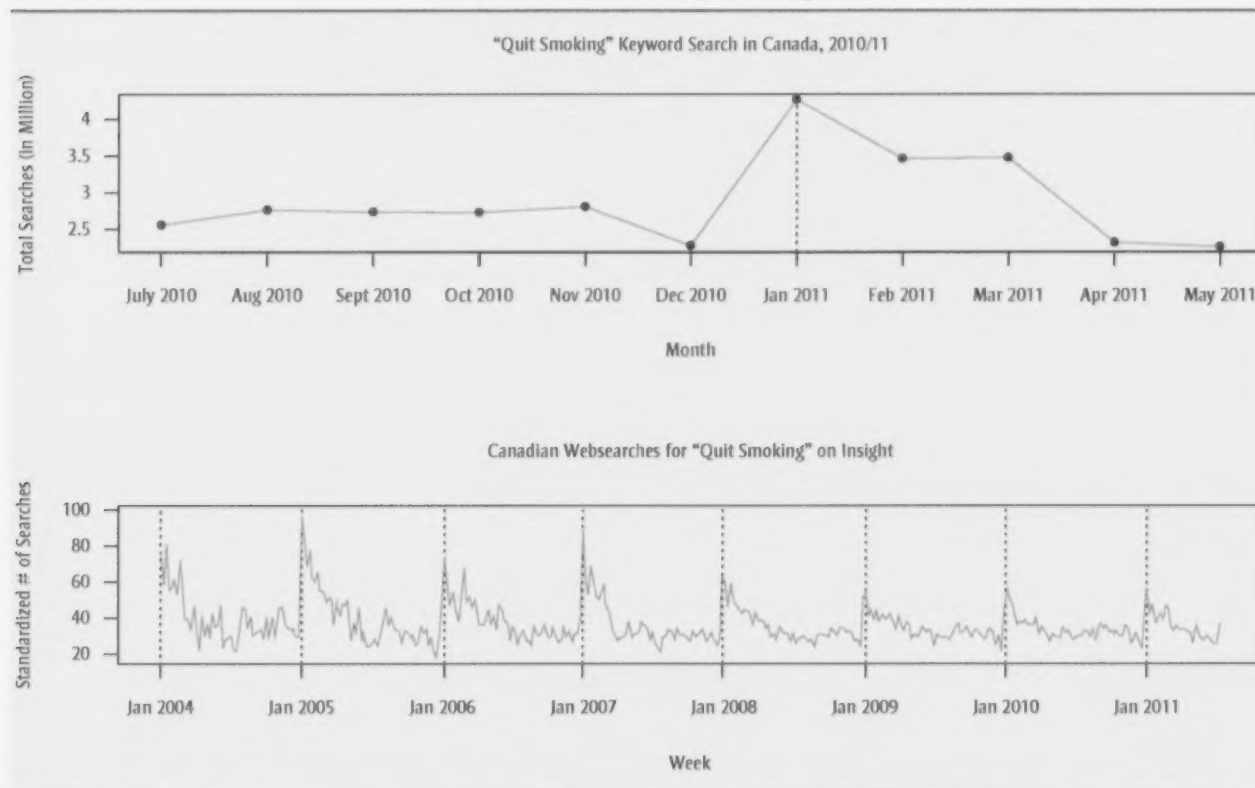


FIGURE 3
Estimated number of monthly searches from July 2010 to May 2011 (top row) and search trend from January 2004 to January 2011 (bottom row) for the search term "quit smoking"



effects: specifically, distinct increases in search traffic during the month of January. We speculate that this pattern is tied to setting New Year's resolutions—previous studies have found that almost 50% of Americans initiate health-related behaviour changes involving weight loss, smoking cessation and/or exercising at this time.¹⁸ This phenomenon could represent a promising opportunity to implement seasonally tailored Internet-based health campaigns and interventions.

We suspect that the high volume of searches for "LA Fitness" for "physical activity / exercise" represent searches for the multinational chain of private fitness gyms that was using an Internet-based advertising campaign to promote its business.¹⁹ We also observed a distinctive peak for "healthy eating / weight loss" in the week of May 23 to 29, 2010 (see Figure 2, bottom row). We could not identify any health promotion events²⁰ or news headlines²¹ during that week to

explain the spike in the number of searches. However, the finale of the Season 9 of "The Biggest Loser," a television reality show that features obese people competing for cash prizes by losing high percentages of their initial weight, aired on May 25, 2010 to approximately 9.4 million viewers.²² While the sharp rise in the searches for "healthy eating / weight loss" may have been related to this broadcast, it is also possible that the increase in search activity may represent a seasonal trend. Further research is needed to confirm this as a regular opportunity to promote cancer prevention-related health behaviours.

The large number of Canadians (more than 15 million in 2009)⁸ actively searching the Internet for health-related information represents a valuable opportunity to support those modifiable risk factors that are relevant to cancer prevention. Online health information has demonstrated the potential to influence behaviour. For

example, more than 70% of Internet users report that the health information they find online influences a treatment decision.^{7,9} Moreover, access to reliable information is linked to "reduced anxiety, increased feelings of self-efficacy, and a decrease in utilization of ambulatory care."²³ Although a great deal of useful health information is available on the Internet, a substantial portion of the content may not be evidence-based. For example, much of the content on stopping smoking available on the video-sharing website, YouTube.com, is not derived from evidence-based cessation strategies.²⁴

Strengths and limitations

There are several limitations associated with this research. First, the monthly search numbers are estimates provided by Google and do not reflect the exact number of searches for each term. Second, it is not possible to identify how many

different individuals conducted the searches; some individuals may be responsible for multiple searches, while others may have conducted a single search. In some cases, we were unable to determine if a related search term was used to obtain specific information on the concept under investigation. For example, some people typing in the search term "weight loss" may not necessarily be searching for information on how to lose weight but for explanations for sudden weight loss. However, most terms, especially those with high frequencies, did appear to be directly relevant to this investigation. In addition, the three sets of keywords examined in this study did not include content related to other modifiable risk factors relevant to cancer prevention, for example, reducing alcohol use and exposure to ultraviolet and ionizing radiation, and occupational exposures. Further research is needed to investigate the search activity related to these and other modifiable risks factors.

Conclusion

The continued growth of the Internet in terms of accessibility and content represents a rapidly expanding opportunity for cancer prevention agencies to disseminate evidence-based information and resources. Online interventions addressing health issues such as smoking, nutrition and physical activity are increasingly popular;^{25,26} the keywords and the related terms examined were associated with more than 240 million searches in 2010 alone. The growing popularity of new Internet interfaces (e.g. smartphone and tablet applications) represents additional opportunities to reach more people in interactive ways. The identified trends suggest that it is worthwhile exploring ways of tailoring online content about physical activity, smoking cessation and healthy eating to specific times of the year, for example, via the *Live Well* program run by the Canadian Cancer Society, Key stakeholders in cancer prevention, for example, the Canadian Cancer Society, Canadian Partnership Against Cancer and British Columbia Cancer Agency, need to identify Internet knowledge translation priorities and work with community health agencies and provincial health authorities to develop

evidence-based strategies to support behaviour change linked to modifiable risk factors for cancer.

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Emergency department presentations for injuries associated with inflatable amusement structures, Canada, 1990–2009

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This article has been peer reviewed.

Abstract

Introduction: Inflatable amusement attractions, structures that are air-supported and inflated by a blower, have recently gained popularity. The purpose of this study was to describe the epidemiology of inflatable-related injuries presenting to Canadian emergency departments.

Methods: The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) is an injury and poisoning surveillance system presently operating in the emergency departments of all 11 pediatric and 4 general hospitals across Canada. The CHIRPP was searched for cases of injuries associated with commercial inflatable amusement structures.

Results: Overall, 674 cases were identified over the 20-year surveillance period, during which time the average annual percent increase was 24.6% (95% CI: 21.6, 27.7). Children aged 2 to 9 years were the most frequently injured (59.3/100 000 CHIRPP cases), and fractures accounted for 34.5% of all injuries.

Discussion: A sharp increase in emergency department visits for injuries associated with commercial inflatable amusement structures has been observed in recent years. Injury mechanisms could be mitigated by product design modifications and stricter business operational practices.

Keywords: injury prevention, injury surveillance, inflatable, CHIRPP, product safety

Introduction

Inflatable amusement attractions, that is, structures that are inflated and supported by a blower, have gained popularity in recent years. "Inflatables" come in a variety of shapes and sizes but can be classified into five broad categories: bounce houses, slides, interactive attractions (wrestling, boxing, bungee), obstacle courses, and climbing walls.¹ From an economic perspective, this is a potentially lucrative business opportunity due to the low initial investment on start-up and the growing demand.¹ Standards exist at both the international and national levels;^{2–4}

however, except in Australia, these standards are not enforced by law. In Canada, only the electrical blower is under the jurisdiction of the Standards Council of Canada. The norm governing children's play spaces and equipment (CAN/CSA-Z614-07) is not applicable to inflatable play structures.⁵

The Consumer Product Safety Commission (CPSC) has reported an increase in injuries related to inflatable amusement attractions in the United States. About 1300 cases (non-occupational) occurred in 1997, and 4900 in 2004.⁶ This number was subsequently

revised to 6101 in that year, and increased to 8348 cases in 2007, according to a CPSC memorandum.⁷ The most recent study using the same data source provided further refinements to the count and rate estimates for the period 1990 to 2010.⁸ In that study, there was a 15-fold increase in the number and rate of injuries between 1995 and 2010, with 11 311 incidents estimated for 2010.⁸ In addition, the CPSC is aware of 8 non-occupational fatalities involving inflatables between 2001 and 2007.^{1,7} Apart from the CPSC surveillance reports, the literature on injuries associated with inflatables in other countries, including Canada, is sparse.^{9–19}

The industry is also growing in Canada, and more than 100 companies that rent inflatables were listed in the Yellow Pages (www.Yellowpages.ca), a national online business directory, in December 2011. A historical search using the Google Canada search engine (www.Google.ca) for webpages containing "rental" ("inflation") OR "bouncy") show a sharp increase since 2008. Apart from one reported death,^{1,20} studies on injuries associated with inflatable play structures in Canada are lacking. As two of its main goals, Canada's principal injury surveillance system, the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP),²¹ identifies trends in product-related injuries and poisonings and provides detailed circumstances surrounding the injury event to inform injury prevention and mitigation programs.

The purpose of this study was to describe the epidemiology and characterize the temporal trend of Canadian emergency

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department presentations for injuries related to inflatable amusement structures among children and youth.

Methods

Data source

The CHIRPP is an injury and poisoning surveillance system that gathers information from the emergency departments of all 11 pediatric and 4 general hospitals across Canada.^{21,22} In operation since 1990, the CHIRPP system runs on an Oracle platform and currently contains about 2.2 million records (injury events). When an injured person or the accompanying parent or caregiver presents to an emergency department that is a CHIRPP site, hospital staff ask them to complete one side of a CHIRPP data collection form and the staff subsequently fill out the reverse side with clinical data. The information collected includes activity at the time of injury, activity leading to the injury, the direct cause of the injury, contributing factors, time and place of the injury event, the patient's age and sex, up to 3 injuries (body part and nature of injury) and the treatment received in the emergency department. Narrative fields provide information to further refine the coding and identify rare events and consumer products. All collected data are reviewed by the CHIRPP site co-ordinator for any missing information. Completed forms are sent to the Public Health Agency of Canada in Ottawa for entry by a trained coding team. Although only select hospitals report to CHIRPP, previous research has shown that the data collected through the program represent general injury patterns among Canadian youth.²³ Previous investigations have also reported on other methodological aspects of CHIRPP.²⁴⁻²⁸

Case selection

In October 2011, we conducted a search of the CHIRPP database for injuries related to inflatable play structures that had occurred between 1990 and 2009 (ages 0–18 years; 1 775 633 total records searched). Cases were selected (1) if any of the six contributing factor code fields contained the code for amusement rides and structures

(CHIRPP code 610), and (2) if the narrative fields (*Injury Event Description*, *Product*, *Place*) contained any of the following text strings: "INFLAT," "AIR CASTLE," "BOUNCY CASTLE," "GONFLABLE" or "MOON WALKER." Since the injury patterns associated with the smaller units intended for home use are likely to be different and the focus of this study was on large commercial devices, we reviewed all case narratives individually and initially separated records by location, retaining incidents occurring at fairgrounds, arenas, public parks, malls, parking lots, commercial recreational areas (indoor or outdoor) or on school grounds or in school gymnasiums (as part of a "family day" or "orientation day"). Incidents that took place at a private home or where the location was unknown were retained only if the narrative fields indicated that the inflatable play structure was a day rental (for a birthday party, for instance). Other exclusions included inflatable mattresses and inflatable toys (including small inflatable "bouncy houses" designed for indoor use).

Statistics and data analysis

Since CHIRPP is not population-based, data are presented in terms of proportions rather than strict counts. Age, sex, and year counts were normalized to the total numbers in the database (presented as the number per 100 000 CHIRPP cases in the given age group, sex or year) according to the following expressions:

Normalized age – sex proportion =

$$\left(n_{age,sex}^{inflatable} / N_{age,sex}^{CHIRPP} \right) \times 100\,000$$

where $n_{age,sex}^{inflatable}$ is the number of inflatable-related cases for the given age group and sex, and $N_{age,sex}^{CHIRPP}$ is the total number of cases in CHIRPP for the same age group and sex.

Normalized annual proportion =

$$\left(n_{year}^{inflatable} / N_{year}^{CHIRPP} \right) \times 100\,000$$

where $n_{year}^{inflatable}$ is the number of inflatable-related cases for the given year, and N_{year}^{CHIRPP} is the total number of cases in CHIRPP for the same year.

Year-to-year variations, likely due to small sample sizes, were smoothed by applying

a 5-point central moving average (CMA) to the normalized proportions.²⁹

Temporal trends in the normalized annual proportions were examined in two ways: the average annual percent change (AAPC) in the normalized proportion for the overall period (1990–2009) and for the most recent 10-year period (2000–2009) were calculated with 95% confidence intervals (CI) using the expression:

$$AAPC = [e^{\beta} - 1] \times 100$$

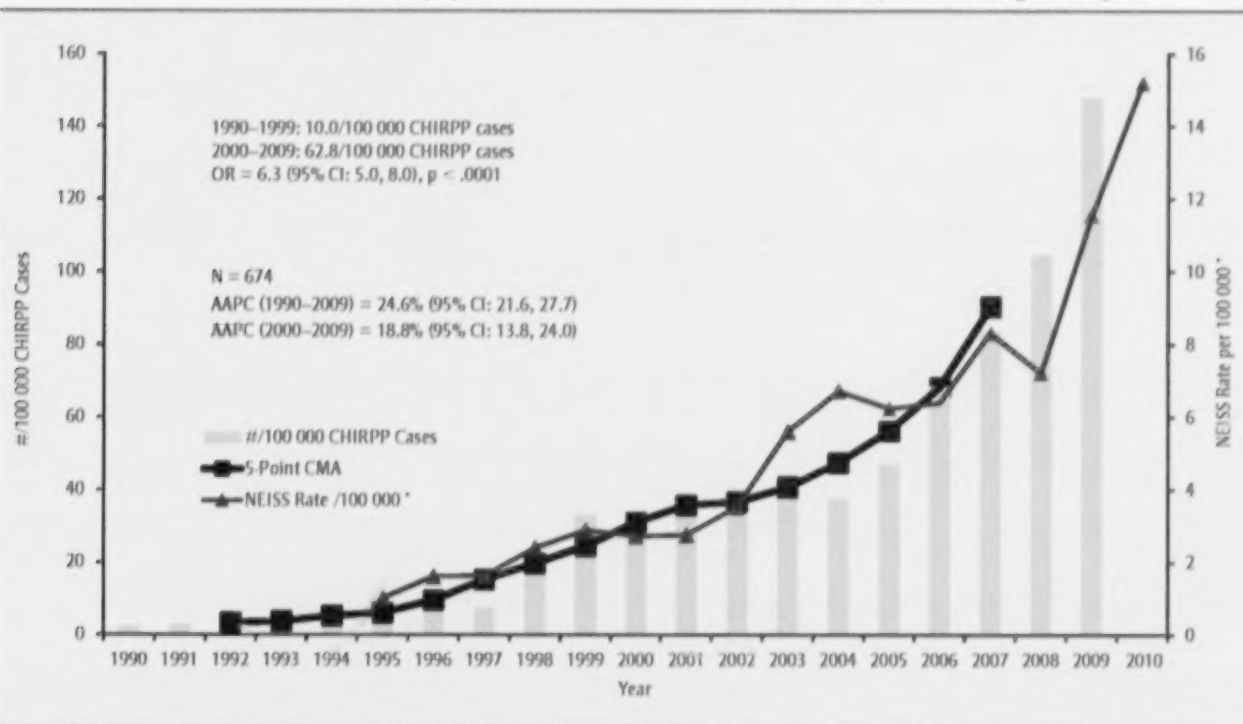
where β is the slope from a regression of log normalized proportion on year. The data were also separated into two 10-year time blocks and analyzed for period-to-period trends (χ^2 test, $p < .005$). Other results are presented in conventional descriptive format. All analyses were performed using the statistical software SAS version 9.2 (SAS Institute Inc., Cary, NC, US) and Microsoft Excel 2007 (Redmond, WA, US).

Results

Of the 674 CHIRPP cases identified over the 20-year period, 2 were occupational; in both these cases, the employees (boys, 15 and 17 years old) fell from the structure. Figure 1 shows the annual trend–normalized proportion by year for the period 1990 to 2009. Data from the U.S.⁸ is included for comparison. The normalized proportion shows an exponential increase ($R^2 = 0.95$ for the logarithmically transformed data). The proportion of patients presenting to emergency departments for inflatable-related injuries has risen sharply in recent years, with 46% of the cases occurring between 2007 and 2009. Overall, there has been an average annual increase of 24.6% (95% CI: 21.6–27.7), and in the most recent 10-year period, the average increase was 18.8% (95% CI: 13.8–24.0). From 1990 to 1999, there were 10.0 cases per 100 000 CHIRPP cases of all types. This proportion has increased 6-fold to 62.8 cases per 100 000 CHIRPP cases in the period from 2000 to 2009 ($p < .0001$).

Figure 2 details the normalized age and sex proportion. Children aged 5 to 9 years, both male and female, were the most frequently injured (57.2/100 000 and 74.6/100 000, respectively). Although

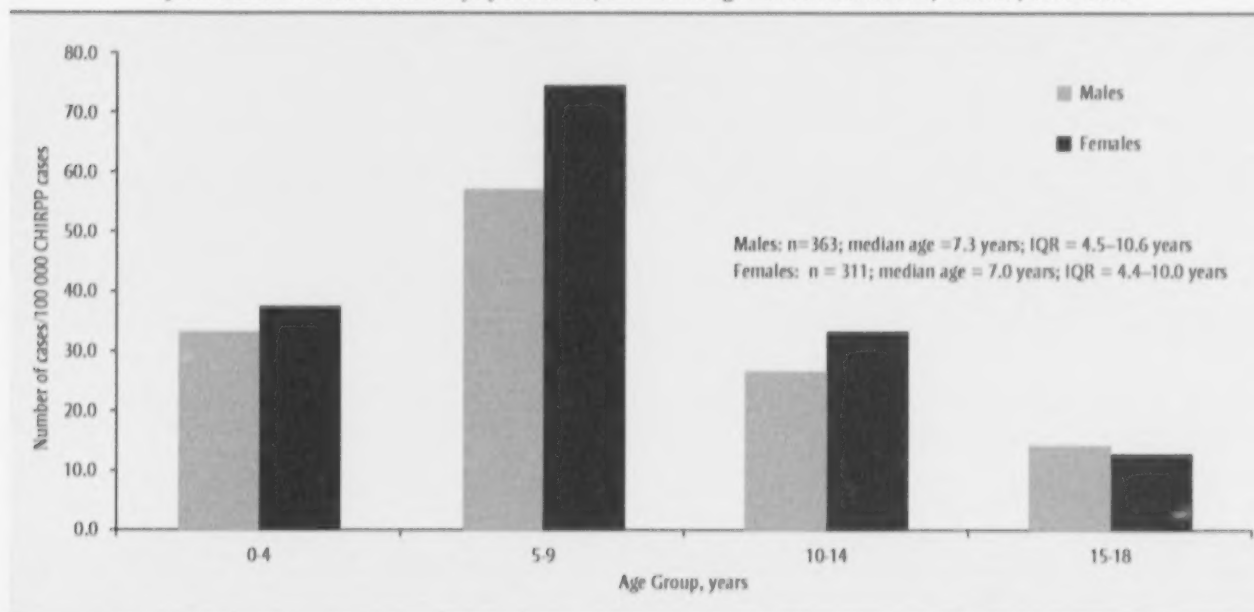
FIGURE 1
Injuries associated with inflatable play structures, normalized annual trend, CHIRPP, 1990–2009, ages 0–18 years



*Source: National Electronic Injury Surveillance System (NEISS). U.S. Consumer Product Safety Commission.⁸

Abbreviations: CI, confidence interval; AAPC, average annual percent change; CHIRPP, Canadian Hospitals Injury Reporting and Prevention Program; CMA, central moving average; NEISS, National Electronic Injury Surveillance System.

FIGURE 2
Injuries associated with inflatable play structures, normalized age and sex distribution, CHIRPP, 1990–2009



Abbreviation: IQR, interquartile range.

TABLE 1
Epidemiology of injuries (n = 695) associated with inflatable amusement structures, CHIRPP,
1990–2009, ages 0–18 years

Characteristic	Cases (n = 674),	
	n	%
Location		
Public space ^a	412	61.1
School ^b	103	15.3
Private home ^c	97	14.4
Unknown ^d	62	9.2
Category of inflatable		
Bouncy house ^e	501	74.3
Slide	135	20.0
Obstacle course ^f	28	4.2
Unknown	10	1.5
Mechanism		
Bad landing	264	39.2
Ejection ^g	211	31.3
Impact with other person ^h	119	17.7
Attempting somersault	28	4.1
Body part caught ⁱ	23	3.4
Structure deflated	15	2.2
Structure collapse due to wind ^j	1	0.2
Unknown	13	1.9
Treatment in emergency department		
Left without being seen	11	1.6
Advice only ^k	154	22.8
Treated, follow up if necessary	227	33.7
Treated, medical follow-up required	229	34.0
Held for prolonged observation in emergency	22	3.3
Admitted to hospital	31	4.6

Abbreviation: CHIRPP, Canadian Hospitals Injury Reporting and Prevention Program.

^a Includes fairs/grounds, arenas, public parks, malls, parking lots, commercial recreational areas (indoors or outdoors).

^b On school grounds or in the school gymnasium as part of a school "family day" or "orientation day."

^c Includes only cases where the inflatable was a day rental of a commercial structure that was installed in the back or front yard of the residence.

^d Includes only cases where the narratives provided enough information to reasonably assume that the inflatable structure was a commercial type (e.g., "many kids jumping on a very large inflatable bouncy castle at a birthday party").

^e Designed for multiple children jumping at the same time and commonly called "bouncy castle," "air castle," "inflatable trampoline," "jump house" or "moon walker."

^f Obstacle course, i.e. can be a hybrid structure for climbing, jumping and sliding.

^g Patient was ejected from the structure (either by bouncing or falling out, after being pushed by another person or upon disembarking) and landed on the ground or floor or struck a fixed object.

^h Child or adult (excluding ejection cases).

ⁱ Body part caught in part of structure (seams, support bars, flaps).

^j In this case, the patient was a bystander who was struck by the collapsing structure.

^k Includes diagnostic testing and referral to family doctor. No treatment received in emergency department.

males accounted for about 54% of all cases, when normalized for total numbers in the database, females were more frequent in every age group except in the 15- to 18-year age group.

Almost three-quarters of incidents occurred on a Friday, Saturday or Sunday (71%), and where the time of day was reported (n = 499), about 55% occurred between 1 p.m. and 5 p.m.

Incidents peaked in June (23.7%), and 70.2% occurred between June and September. Table 1 details the epidemiology of other variables. Just under two-thirds of the incidents occurred in public spaces such as fairgrounds, parking lots and other commercial recreational areas. Schools and private homes accounted for about 30%. Most of the structures involved were "jump houses" or "bouncy castles" (74.3%). Bad landings and ejections were the most common mechanisms of injuries, accounting for about 70% of incidents. Ejections were most common on slide structures, occurring in 61 of the 135 (45.2%) cases. Caught body parts occurred rarely, but of the 23 cases, 10 (43.5%) resulted in a fracture. Overall, the admission rate (which is a proxy for severity) was 4.6%; however, the rate was 7.1% for ejections and for those attempting somersaults.

Table 2 details the distribution of all 695 injuries sustained by the 674 patients between 1990 and 2009. Up to three injuries can be reported in CHIRPP; if there are more than three, the most serious two are reported and the third is recorded as multiple injuries. Overall, fractures represented over one-third (34.5%) of all injuries, and the lower extremity was the most frequently injured body region (40.3%). About 13% of all injuries were to the head and face, and of those, 48.9% were brain injuries (minor closed head injury, concussion) and 3.3% were fractures (skull/facial).

Discussion

Temporal trend

One of the purposes of the CHIRPP surveillance system is to provide timely data that allows the detection of emerging injury hazards. Figure 1 shows an exponential increase in injuries related to commercial inflatable amusement structures. Because CHIRPP data are numerator-based, a large portion of the increase in number of cases is likely due to increasing exposure. However, more hazardous inflatable designs, increases in reporting and changes in safety procedures could also account for some proportion of the increase. Figure 1 also shows rate esti-

TABLE 2
Injuries^a associated with inflatable amusement structures, CHIRPP, 1990–2009, ages 0–18 years

Injury ^a	Injuries, (n = 695)	
	n	%
Lower Extremity	280	40.3
Fractures	99	14.2
Tibia/fibula	35	
Foot, toes	28	
Ankle	27	
Femur	5	
Patella	4	
Bruise, abrasion, soft tissue	92	13.2
Sprain, strain, dislocation	84	12.1
Lacerations	5	0.7
Upper Extremity	238	34.2
Fractures	138	19.8
Elbow	47	
Forearm	46	
Wrist, hand, finger	26	
Humerus	14	
Clavicle	4	
Scapula	1	
Sprain, strain, dislocation	50	7.2
Bruise, abrasion, soft tissue	48	6.9
Lacerations	2	0.3
Head, Face, Neck	122	17.6
Brain ^b	45	
Facial bruise, abrasion, laceration, soft tissue	29	
Neck sprain/strain	21	
Eye, dental, scalp bruise, abrasion, laceration	15	
Neck bruise, abrasion, soft tissue	9	
Skull, facial fracture	3	
Spine, Cord, Trunk	36	5.2
Back bruise, abrasion, soft tissue	16	
Back sprain, strain	9	
Thoracic bruise, abrasion, soft tissue, laceration	8	
Pelvic bruise, abrasion, soft tissue	2	
Back – crushing injury	1	
Other	19	2.7
No injury detected	9	
Unknown	10	

Abbreviation: CHIRPP, Canadian Hospitals Injury Reporting and Prevention Program.

^a The CHIRPP records up to 3 injuries. Table 2 includes all injuries, i.e. 674 patients suffered 695 injuries.

^b Includes minor closed head injuries, concussions and intracranial injuries.

mates from the U.S. for 1990 to 2010.⁸ Although not directly comparable to CHIRPP proportions, these estimates are population-based and show a similar exponential trend ($R^2 = 0.94$ for the logarithmically transformed data). Also,

some of the earlier U.S. estimates showed very wide confidence intervals. The authors attributed the high variance to clustering of incidents: one of the hospitals in the sample is located near an inflatable amusement park and single

events often result in multiple injuries creating a cluster at the local hospital.⁷ However, all of these rates are just annual estimates based on the total population. The most informative denominator would be usage numbers (number of companies, average number of rentals and number of uses per rental, etc.). Such information has been difficult to determine in the U.S.,⁷ and we were unable to find any such information for the Canadian situation. Regardless, the increase shown in Figure 1 is important for injury prevention purposes.

Most inflatables are made overseas, in China, Hong Kong and the Philippines, and many of the manufacturers are not aware of international or Canadian standards. The costs of manufacturing inflatables also appear to be decreasing.¹ Given this, we may expect the current trend of increased availability to continue.

International literature

The literature on injuries associated with inflatable structures is not extensive. Table 3 summarizes all the studies (excluding case reports) currently available. Of these, the four from the U.S.^{1,7,8,13,16} had results most similar to ours with regard to the age range, temporal trend, proportion of all injuries that were fractures, and the proportion of injuries involving the head and face. The proportion of patients admitted to hospital was also similar (3.4%–4.0% vs. 4.6%), but this comparison must be interpreted with caution since jurisdictions have different admissions policies.

The type of inflatable involved in the incident was reported on in most studies. Sceviour¹ found that “bouncy castles” or “jump houses” were the type of inflatable in 96.7% of all incidents. Thompson et al.⁸ only included structures designed for jumping; slides not attached to a “jump house” were excluded. Our study used slightly different criteria and thus the distribution was somewhat different, with about three-quarters bouncy castles and one-fifth slides. Most of the other studies^{9,16,18} focussed specifically on jump houses or bouncy castles. In 1988, Olsen¹⁷ reported on an early form of bouncy castle

TABLE 3
Comparison of studies and reports describing injuries associated with inflatable amusement structures

Reference	Country	Study years	Number	Peak age group, year	Percent fractures, %	Percent admitted into hospital, %	Percent of injuries to the head/face, %
Seviour, 2006 ¹	United States	1997–2004	18 554 ^a	3–11	33.5	N/A	N/A
Roegner, 2009 ²	United States	2003–2007	31 069 ^a	5–14	29.0	4.0	15.0
Thompson et al., 2012 ³	United States	1990–2010	64 657 ^a	6–12	27.5	3.4 ^b	27.8 ^c
Schwend, 2009 ^{11,d} Avoian et al., 2008 ^{16,d}	United States	2002–2007	49	7–9	100.0	N/A	0.0
Levene, 1992 ¹⁴	United Kingdom	N/A	105	5–14	5.7	1.9	N/A
Kirketerp-Møller et al., 1996 ¹⁵	Denmark	1993	91	N/A ^e	31.0	4.4	N/A
Olsen, 1988 ¹⁷	Denmark	1984–1985	78	11–16	31.0	9.0	1.3
O’Flynn and Cunningham, 2006 ¹⁸	Ireland	2006	13	N/A ^f	38.5	7.7	0.0
McFaul and Keays, 2013 (this current study)	Canada	1990–2009	674	2–9	34.5	4.6	13.2

Abbreviation: N/A, not applicable.

^a Weighted.

^b Includes those held for observation < 24 hours.

^c Includes concussion/closed head injury and face.

^d The studies by Schwend and Avoian et al. used the same data.

^e The studied range was 0–19 years. No distribution was provided.

^f The studied range was 3–15 years. No distribution was provided.

called “air cushions,” essentially giant pillows with no containment walls. Due to a large number of children jumping at the same time and the curvature of the structure, chaotic rebounding can be expected and trajectories difficult to calculate. As such, 70% of the incidents involved collision with another person. Most subsequent studies^{9,16,18} involved more modern structures. Healy et al.⁹ describe a case report of a 14-year-old girl with partial thickness friction burns on her knees and elbows, while our study had no cases of burns. McGuire et al.¹¹ reported on two cases of adult women sustaining cervical spinal fractures (hyperflexion mechanism) on a bouncy castle; in our data, trunk injuries accounted for 5.5% of all injuries and there was one spinal fracture and one dislocation. In 2008, Avoian et al.¹⁶ studied 49 cases of inflatable-related injuries at a Level 1 trauma centre in Los Angeles (CA). A sample of 21 families were contacted in a follow-up survey to gather more details regarding the injury event; all 21 cases involved rented inflatable bouncers at private homes and the mechanism of injury was collision with another child in 14 cases, ejection in 19 and a bad landing in 3.

Fatalities

Knowing the details of fatalities is useful for prevention purposes since many non-fatal cases may involve similar circumstances and could be considered as near-misses. Although CHIRPP is not a good source of mortality data (because emergency department data do not capture people who died before they could be taken to hospital or those who died after being admitted), and there were no fatalities in the present study, a number of deaths have been reported on internationally. In the U.S., the CPSC is aware of 8 non-occupational deaths involving inflatable amusement structures.^{1,7} Three occurred in 2001, 2 of which were suffocations involving a 2- and a 5-year-old; a 21-year-old man broke his neck while jumping in a bounce house in 2002; a 15-year-old male and an 18-year-old male fell from slides at school events in 2003 and 2004, respectively; a 24-year-old female fell from an inflatable climbing wall at an amusement site in 2005; and a 3-year-old was struck by two adults who fell through a gap in a “King of the Hill,” a large inflatable, in 2007. Three other deaths from outside of the U.S. have also been reported.^{1,19} In 2001, an 8-year-old

Australian girl was killed when she fell from an inflatable that was lifted 3 m from the ground by a sudden gust of wind.¹⁹ A similar case occurred in Budapest in 2007 when a child fell 27 m from an inflatable that was lifted up by a gust of wind.¹⁹ The only reported Canadian death (occupational) involved a 19-year-old male who died from head injuries after a fall from an inflatable climbing wall,^{1,20} though it is very possible that there have been other unreported deaths.⁶ A significant proportion of deaths and severe injuries involved those over 18 years of age. Because these age groups are under-represented in CHIRPP, they were not included in this study; nevertheless, we identified 15 cases when we did an initial search.

Trampolines

Comparing inflatables with trampolines is inevitable. In 2007, the Canadian Paediatric Society released a position statement regarding trampoline use in homes and playgrounds, and highlighted CHIRPP data (1990–2003) in that report.³⁰ Based on hospital admissions and percentages of fractures, injuries related to trampolines appear to be more serious. Trampoline-related injuries recorded in

CHIRPP have seen a sharp increase in recent years, similar to that associated with inflatables, and the Public Health Agency of Canada is currently undertaking an updated study of these injuries.

Injury prevention/mitigation

The results of this and other studies point to various areas for prevention.¹ Modifying product designs with respect to materials, structure height, openings and anchoring systems may help to mitigate certain types of injuries. Operators must be aware of weather conditions such as wind and rain that can facilitate falls from the structure. They will need to follow stricter guidelines to prevent overcrowding and equipment failure (electrical or otherwise), and attentive supervision should also be recommended. Although more data are needed, there is some suggestion that inflatable slides are more hazardous than bouncy castles: our study found there to be a higher proportion of falls (ejections) from slides than from bouncy castles. Slide structures often have less containment on the portions where users ascend. Finally, more research needs to be done to compare injury severity and mechanism in fixed-site versus mobile inflatables.

Limitations

This study has a number of limitations. It is important to note that the injuries described do not represent all injuries in Canada but only those seen at the emergency departments of the 15 hospitals in the CHIRPP network. Since most of the data come from the pediatric hospitals, which are in major cities, injuries suffered by adults and by older teenagers, who can also be seen at general hospitals, are under-represented in the CHIRPP database, as are those of people who live in rural and remote areas, including Aboriginal populations. Also, as previously mentioned, fatalities are also under-represented. Some very severe injuries may also be missed because the caregivers or the patient was not asked to fill out a form due to the severity of the injuries; unless the site co-ordinator goes back to the charts and fills out a CHIRPP form (in some hospitals this may not

always occur), the case will be missed. There is also the potential for misclassification of cases. In particular, the 162 cases (23.5%) that took place in private homes or unknown locations may not have been rented units but just smaller toy versions.

Conclusions

The number of injuries associated with commercial inflatable amusement structures appear to be increasing in Canada. Injury prevention efforts should focus on standards and operator error in order to halt this rise in injuries and prevent possible fatalities.

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Evolution of the determinants of chronic liver disease in Quebec

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This article has been peer reviewed.

Abstract

Introduction: Chronic liver diseases (CLDs) are a worldwide problem. Morbidity and mortality due to CLDs could be avoided or reduced by targeting the main risk factors, including obesity and alcohol use.

Methods: To describe the evolution of the key determinants of CLDs in Quebec, we studied the trends in obesity, alcohol use, viral hepatitis B and C, CLD mortality and hospitalization rates, and the liver cancer incidence rate between January 1, 1981, and December 31, 2009.

Results: We observed an increase in the obesity indicators among young men and in alcohol use among adolescent girls and middle-aged women. The overall hepatitis B and C incidence and CLD mortality rates are falling. However, liver cancer and mortality rates, especially among men and the elderly, are on the rise.

Conclusion: These results highlight the importance of targeted public health interventions and of maintaining or improving access to care for CLDs.

Keywords: liver disease, epidemiology, chronic disease, risk factors, chronic liver disease

Introduction

Chronic liver diseases (CLDs) have different characteristics in terms of risk factors, incubation, latency, induction and the final state of the disease process. The most common CLDs are associated with chronic viral hepatitis, alcohol use and obesity; the least common are liver cancer and those due to certain genetic, autoimmune and vascular conditions or to drug toxicity.¹

CLDs are responsible for over 80% of primary liver cancers, of which hepatocellular carcinoma (HCC) is the most frequent. Chronic liver inflammation and liver tissue fibrosis provide the ideal conditions for the development of HCC. Thus, patients with HCC usually have a history of chronic viral hepatitis B (HBV)

or hepatitis C (HCV), alcoholic liver disease (ALD) or non-alcoholic steatohepatitis.^{2,3} Alone or in combination, these diseases increase the risk of HCC.⁴⁻⁸

CLDs are a major public health problem worldwide. In England, they are the fifth leading cause of death;⁹ in the United States, they have been among the fifteen leading causes of death in the past decade,^{10,12} with an estimated adjusted mortality rate of 10.3 per 100 000 inhabitants in 2010.¹³ In Canada, 2748 deaths were attributed to CLDs and liver cirrhosis (eleventh leading cause of death) in 2008, of which 1809 (66%) were among men.¹⁴

Morbidity and mortality from CLDs could be avoided or reduced by targeting the main risk factors, including obesity and alcohol use.^{6,8} In addition, some compli-

cations can be avoided through vaccination against hepatitis A (HAV) and HBV and diagnosis and early treatment of chronic hepatitis caused by HCV.^{7,15,16}

To determine the CLD situation in Quebec, we studied their evolution and that of their main determinants. We targeted conditions for which prevention plays an important role.

Methods

Our ecological observational study looked at the period between 1 January, 1981, and 31 December, 2009. The data for the selected health indicators came from the Infocentre de santé publique (Infocentre) of the Institut national de santé publique du Québec (INSPQ), except for those on HBV- and HCV-associated morbidity, which came from Quebec's registry of notifiable diseases (RND). The Infocentre is a secure access portal to health data from various sources.¹⁷

The indicators for the selected CLD determinants were from Statistics Canada's Canadian Community Health Surveys (CCHSs) for 2000/2001, 2003/2005 and 2007/2008.¹⁸ The CCHS surveys Canadians aged 12 years and older living in private households (but excludes residents of reserves and Aboriginal settlements, Canadian Armed Forces bases, institutions and some remote areas), and are representative of Quebec's public health regions.¹⁸

The cases of HBV and HCV reported to the Quebec's RND covered the period from 1 January, 1990, to 31 December, 2009. For HBV, we looked at acute and chronic cases and those for which the status was

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unspecified. For HCV, we looked at all categories combined. These cases are recorded and classified by Quebec's regional public health departments on the basis of the nosological definitions of the ministère de la Santé et des Services sociaux (MSSS).¹⁹ These definitions are similar to those of the Public Health Agency of Canada (PHAC).²⁰ Annual incidence rates per 100 000 population were calculated for acute HBV infections, using as denominators the estimates and projections of the Institut de la statistique du Québec (ISQ). These were made on the basis of the data from the Statistics Canada censuses and published by MSSS.²¹ The HBV and HCV data were analyzed using the software EpiData Analysis version 2.2.1.171.²²

The following health indicators were examined for association with the determinants of CLD: the proportion of the population that was overweight (body mass index [BMI] 25.0–29.9 kg/m²) or obese (BMI ≥ 30 kg/m²)²³ from 2000 to 2008; the proportion of the population that used alcohol occasionally or daily over the previous twelve months from 2000 to 2008; the proportion of the population that had 14 or more alcoholic drinks over a seven-day period from 2000 to 2005; and the proportion of the population that reported heavy alcohol use (five alcoholic drinks on one occasion, i.e. one after another or in a short period of time) 12 or more times per year¹⁸ from 2000 to 2008.

The data sources for the CLD indicators were the MSSS tumour file, the RND, and the system for maintenance and use of data for the study of hospital patients (MED-ÉCHO). ICD-9* codes were used to identify CLDs (571) and liver cancer (115) up to the year 1999, and ICD-10† codes were used to identify ALD (K70) and liver cirrhosis (K74) as of 2000.

We used the following CLD indicators: CLD mortality rates for 1981 to 1999; liver cirrhosis and ALD mortality rates for 2000 to 2007; liver cancer incidence rates for 1986 to 2007; liver cancer mortality rates for 1981 to 2009; and hospitalization rates

for short-term physical care for liver disease for 1990 to 2005.

We adjusted the proportions of the various parameters studied and the incidence, mortality and short-term hospitalization rates for CLD on the basis of age and sex for the overall Quebec population in 2001 and 2006, and calculated 99% confidence intervals (CIs) of the estimates.

Results

The proportion of the Quebec population aged 20 to 64 years old that was overweight showed a slight upward trend, from 44.7% (99% CI: 43.2–46.2) in 2000/2001 to 47.9% (99% CI: 46.3–49.3) in 2007/2008. The overall obesity figures for this population also increased over the same period, from 12.6% (99% CI: 11.6–13.7) to 15.8% (99% CI: 14.6–17.0). Men aged 25 to 44 years showed a particularly marked increase in obesity, from 12.7% (99% CI: 10.6–14.7) to 16.8% (99% CI: 14.1–19.6) (Figure 1).

The overall proportion of the population aged 12 years and older that used alcohol occasionally or daily over the previous 12 months rose slightly, from 81.1% in 2000/2001 to 81.9% in 2007/2008. However, the proportion that drank alcohol daily rose from 8.3% (99% CI: 7.5–9.1) to 10.7% (99% CI: 9.8–11.5) over the same period. This increase was more pronounced in women, from 4.6% (99% CI: 4.1–5.2) to 7.3% (99% CI: 6.3–8.3). We observed similar upward trends in those who had 14 or more alcoholic drinks in a seven-day period between 2000 and 2005. With some exceptions, this upward trend was seen in all the age groups, but particularly in men aged 20 to 24 years. Although their proportions were lower than those among their male counterparts, there were marked increases in those women aged 45 to 64, 20 to 24 and 12 to 19 years who had 14 or more alcoholic drinks in a seven-day period (Figure 2).

For heavy alcohol use (i.e. five or more alcoholic drinks on one occasion 12 or more times per year), the upward trend was observed for both men and women

and for nearly all ages, except for the 12- to 19-year age group. However, the most marked increase was for young adult women (20–24 years). For men in this age group, the proportion rose from 41.2% (99% CI: 33.7–48.7) in 2000/2001 to 46.4% (99% CI: 37.8–55.1) in 2007/2008; for women, it rose from 17.1% (99% CI: 11.9–22.3) to 30.1 (99% CI: 22.9–37.4) over the same period.

From 1990 to 2009, Quebec's RND recorded 28 476 cases of HBV and 33 490 cases of HCV (Figure 3). Of the HBV infections, 14% (n = 3986) were classified as acute and 71% (n = 3986) were classified as chronic; the remaining 15% were unspecified (this proportion rose after 2003). The overall incidence rate of acute cases also decreased significantly, from 6.5 per 100 000 population in 1992 to 0.4 per 100 000 population in 2009; this reduction occurred simultaneously in both sexes and in most age groups, but especially so in the 10- to 19- and the 20- to 39-year age groups (data not shown). The number of reported chronic cases also fell over the same period, from a maximum of 1434 in 1992 to 634 in 2009. The number of HCV infection cases rose significantly in the 1990s, and then started to fall gradually.

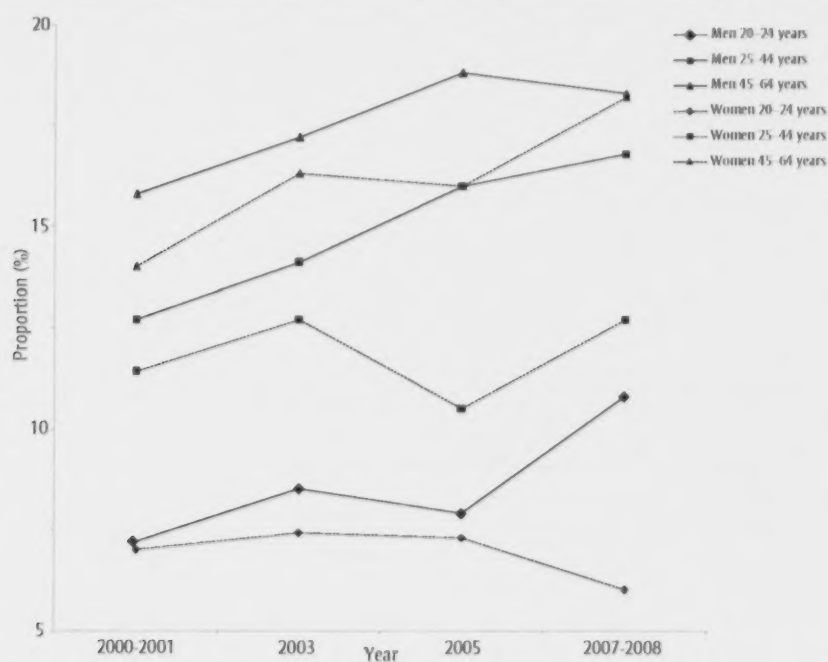
We observed a decrease in overall CLD and liver cirrhosis mortality rates between 1981 and 1999, from 24.2 per 100 000 population (99% CI: 21.5–27.3) to 13.0 (99% CI: 11.3–14.9) for men, and from 8.2 per 100 000 population (99% CI: 6.8–9.9) to 5.8 (99% CI: 4.8–6.9) for women (Figure 4). The mortality rate due to liver cirrhosis remained practically stable from 2000 to 2007; it dropped from 4.7 per 100 000 population in 2000 (99% CI: 4.0–5.4) to 4.6 (99% CI: 4.0–5.2) in 2007. Similarly, ALD mortality rates fell from 3.3 per 100 000 (99% CI: 2.8–3.9) to 3.1 (99% CI: 2.6–3.6) for the same years (Figure 5).

However, an overall increase in liver cancer incidence rates did occur between 1986/1988 and 2004/2006, from 3.8 per 100 000 population (99% CI: 3.4–4.2) to 6.7 (99% CI: 6.7–7.1). This increase was seen for both sexes: for women, this rate

* International Classification of Diseases 9th Revision.

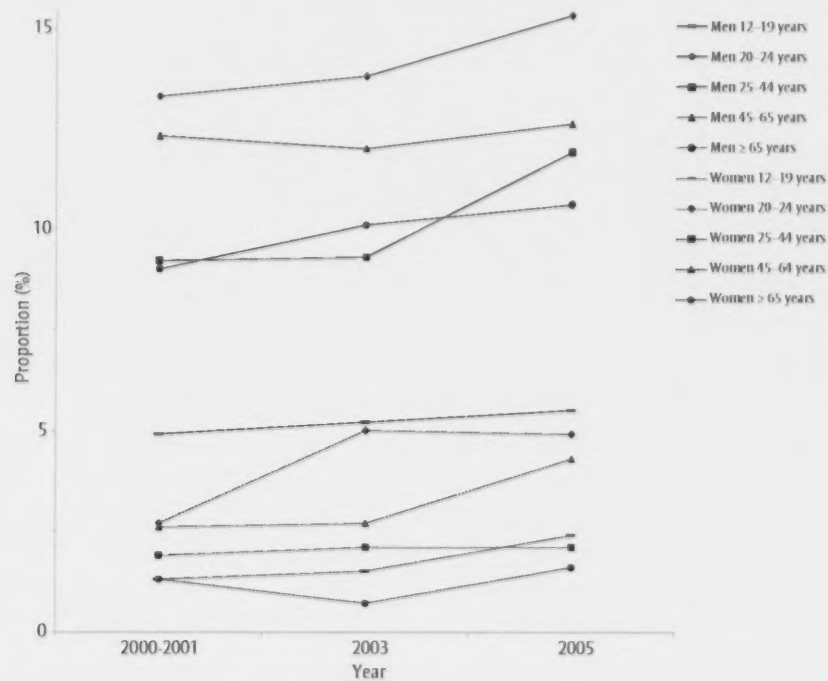
† International Classification of Diseases 10th Revision.

FIGURE 1
Proportion of the population with BMI ≥ 30 kg/m², by age and sex, excluding pregnant women, Quebec, CCHS, 2000–2008



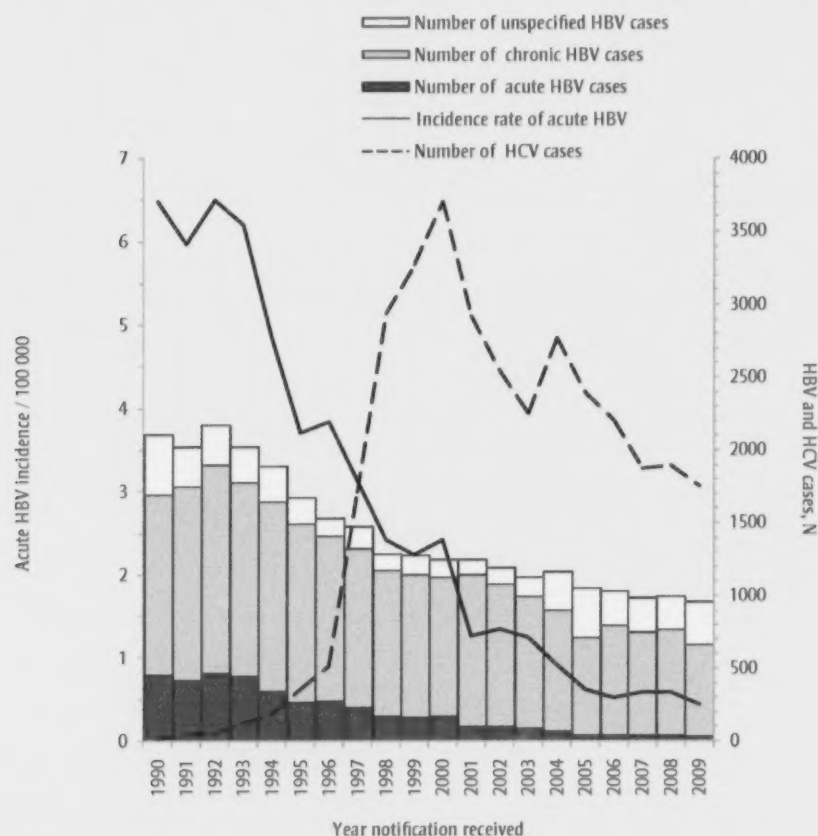
Abbreviations: BMI, body mass index; CCHS, Canadian Community Health Survey.

FIGURE 2
Proportion of the population, age ≥ 12 years, that had ≥ 14 alcoholic drinks over 7 consecutive days, by age and sex, Quebec, CCHS, 2000–2005



Abbreviation: CCHS, Canadian Community Health Survey.

FIGURE 3
Number of cases of acute, chronic and unspecified HBV, number of cases of HCV and annual incidence rate of acute HBV, Quebec, 1990–2009



Abbreviations: HBV, viral hepatitis B; HCV, viral hepatitis C.

rose from 2.3 per 100 000 population (99% CI: 1.9–2.7) to 3.8 (99% CI: 3.4–4.3); for men, it rose from 5.7 per 100 000 population (99% CI: 5.0–6.8) to 10.2 (99% CI: 9.4–11.0). The increase was significant in the 50- to 59-year age group and was largest among people aged 80 years and older; for them the rate rose from 19.6 per 100 000 population (99% CI: 14.5–26.5) to 41.1 (99% CI: 35.6–47.5) (Figure 6).

Similarly, liver and intrahepatic bile duct cancer mortality rates in men showed the same upward trend, from 5.2 per 100 000 population (99% CI: 3.5–5.2) in 1981 to 8.5 (99% CI: 7.4–9.9) in 2009 (provisional data) (Figure 7).

The short-term hospitalization rate due to CLDs fell from 1991 to 1997 and remained relatively stable in the years that followed (Figure 8).

Discussion

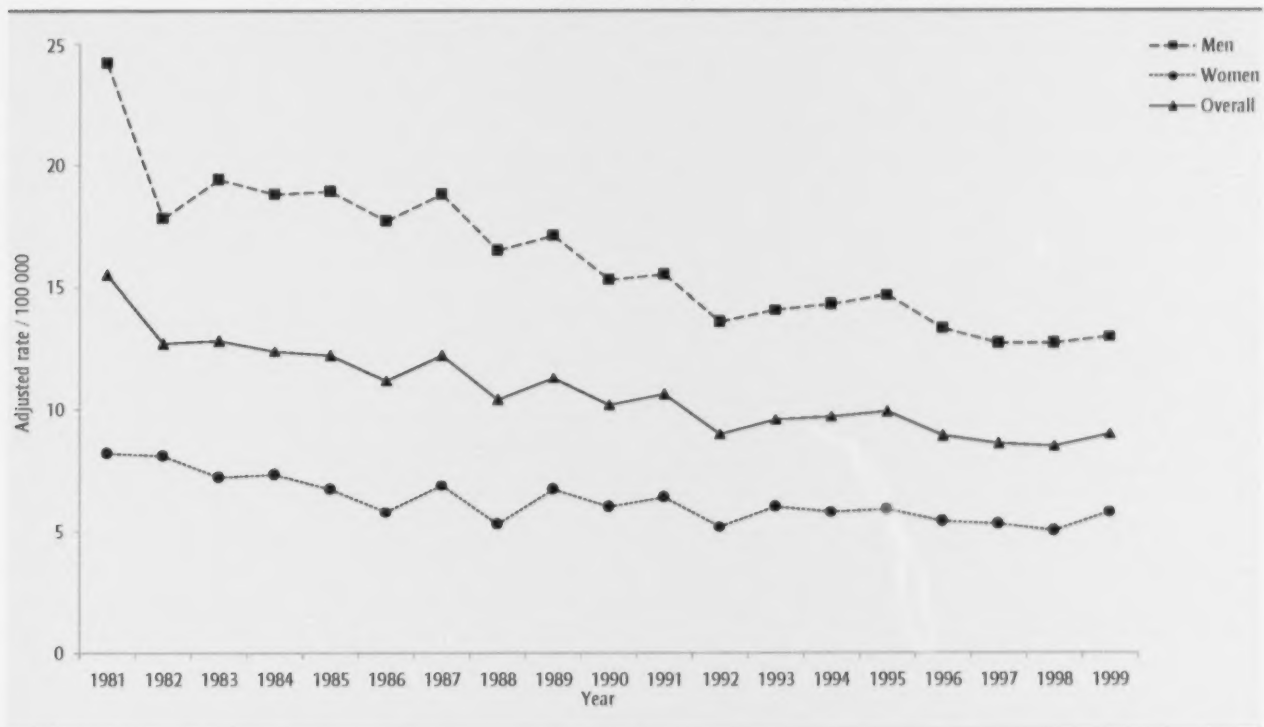
Based on our results, the upward trend in obesity in the Quebec population is alarming, especially among young men. These self-reported figures, drawn from various consecutive cycles of the CCHS, could be 4% to 8% less than directly measured values.^{24,25} Despite this limitation, the trend we observed is in line with the results of an ISQ-published²⁵ study that based its results on direct measurements. This study reported that the prevalence of overweight and obesity among Quebecers aged 18 to 74 years rose from 43% in 1990 to 56% in 2004.²⁵

Obesity is a problem worldwide. In a recent study, Finucane et al.²⁶ estimating the BMI trends in 199 countries and territories among adults aged 20 years and older. They found the 2008 global

prevalence of obesity to be 9.8% (95% CI: 9.0–10.0) for men and 13.8% (95% CI: 13.1–14.7) for women, nearly double the prevalence in 1980 (men: 4.8%, 95% CI: 4.0–5.7; women: 7.9%, 95% CI: 6.8–9.3).²⁶ In a meta-analysis of 17 studies, Larsson and Wolk²⁷ measured the association between weight and CLD risk. They reported a 17% increased risk of liver cancer for overweight and an 89% increased risk for obesity, compared with that for normal weight. The relative risk (RR) was significantly higher for obesity in men (RR = 2.42; 95% CI: 1.83–3.20) than in women (RR = 1.67; 95% CI: 1.37–2.03).²⁷ Further studies will be necessary to add to the body of knowledge on obesity as a risk factor for other CLDs, such as non-alcoholic fatty liver.^{4,28,29}

Alcohol is a known cause of cirrhosis, which predisposes a person to HCC.³⁰

FIGURE 4
Chronic liver disease and liver cirrhosis mortality rates, by sex, Quebec, 1981–1999

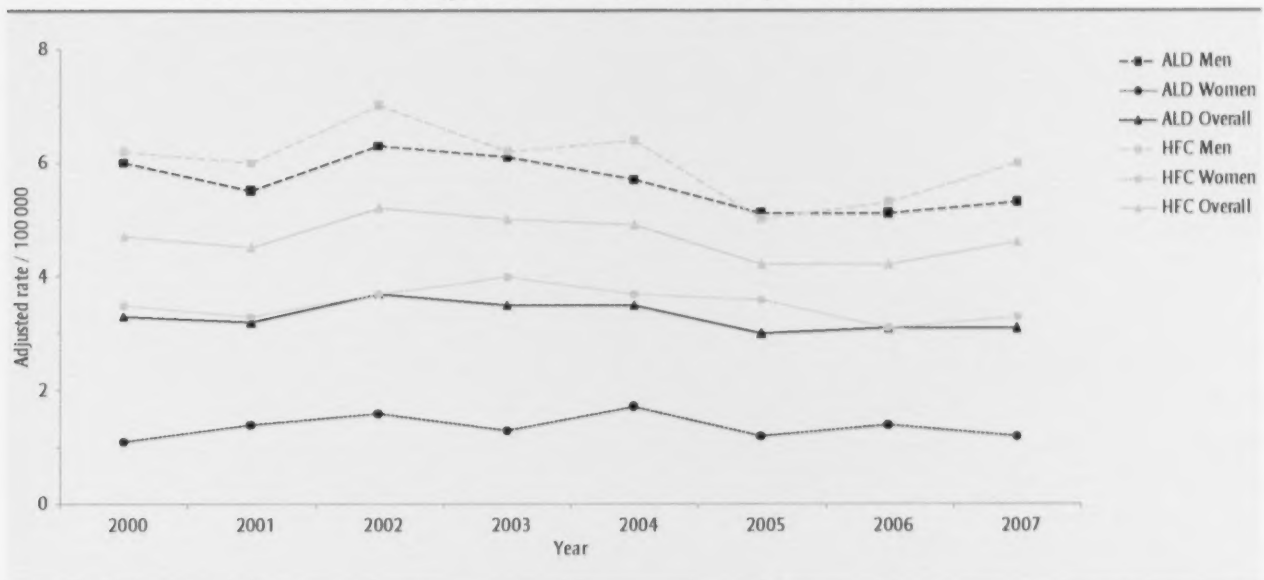


According to a 2010 report, alcohol sales have been on the rise in Quebec since the late 1990s.³¹ During the period of our study, the total proportion of people who drank alcohol remained the same, but the

distribution in terms of frequency and heavy consumption increased. These trends are notable among young people and women. Other authors have reported similar findings.³²

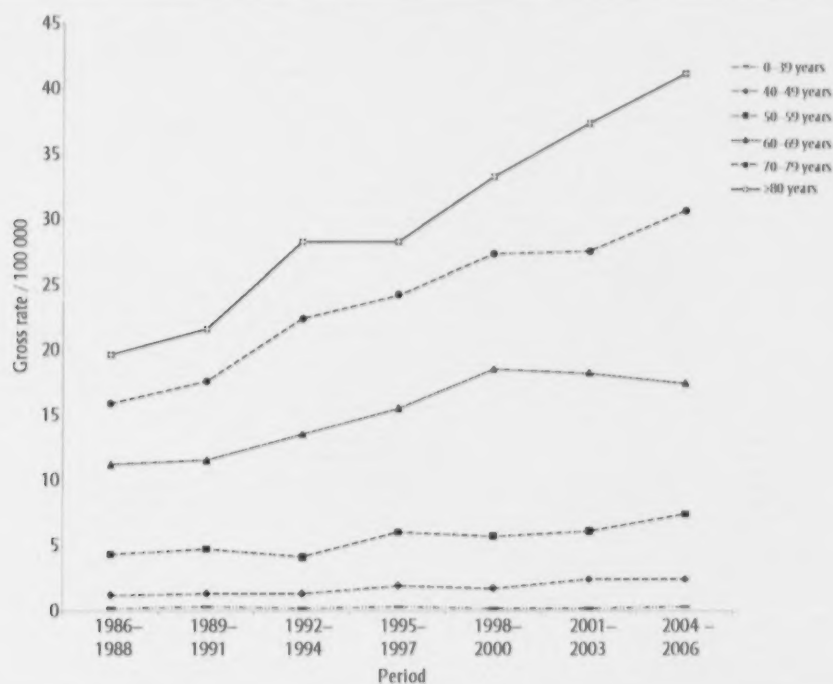
Chronic HBV and HCV infections are known causes of cirrhosis and HCC, and are linked to between 80% and 90% of HCC cases worldwide.³³ Canada is considered a low-endemicity country for these

FIGURE 5
Alcoholic liver disease and hepatic fibrosis and cirrhosis mortality rates, by sex, Quebec, 2000–2007



Abbreviations: ALD, alcoholic liver disease; HFC, hepatic fibrosis and cirrhosis.

FIGURE 6
Liver cancer incidence rates per three-year period, by age, Quebec, 1986–2006



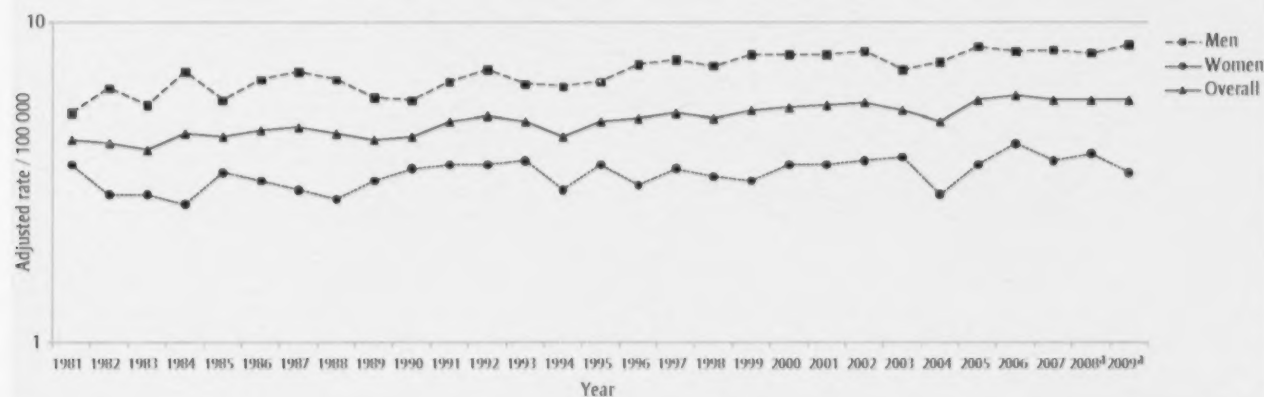
two infections. According to PHAC, 0.7% to 0.9% of the Canadian population has a chronic HBV infection. The HBV reporting rate fell considerably, from 11 per 100 000 population (95% CI: 6.0–18.1) to 3.3 (95% CI: 1.6–4.8) between 1990 and 2007. A similar trend was observed in Quebec, with a marked decrease in incidence rate of acute HBV cases, likely as a result of

expanded HBV immunization, including the school vaccination program introduced in 1994.³⁴

The numbers on reported HCV cases should be interpreted with caution. A large part of the observed increase in the number of cases reported in the 1990s is probably due to improvements in HCV

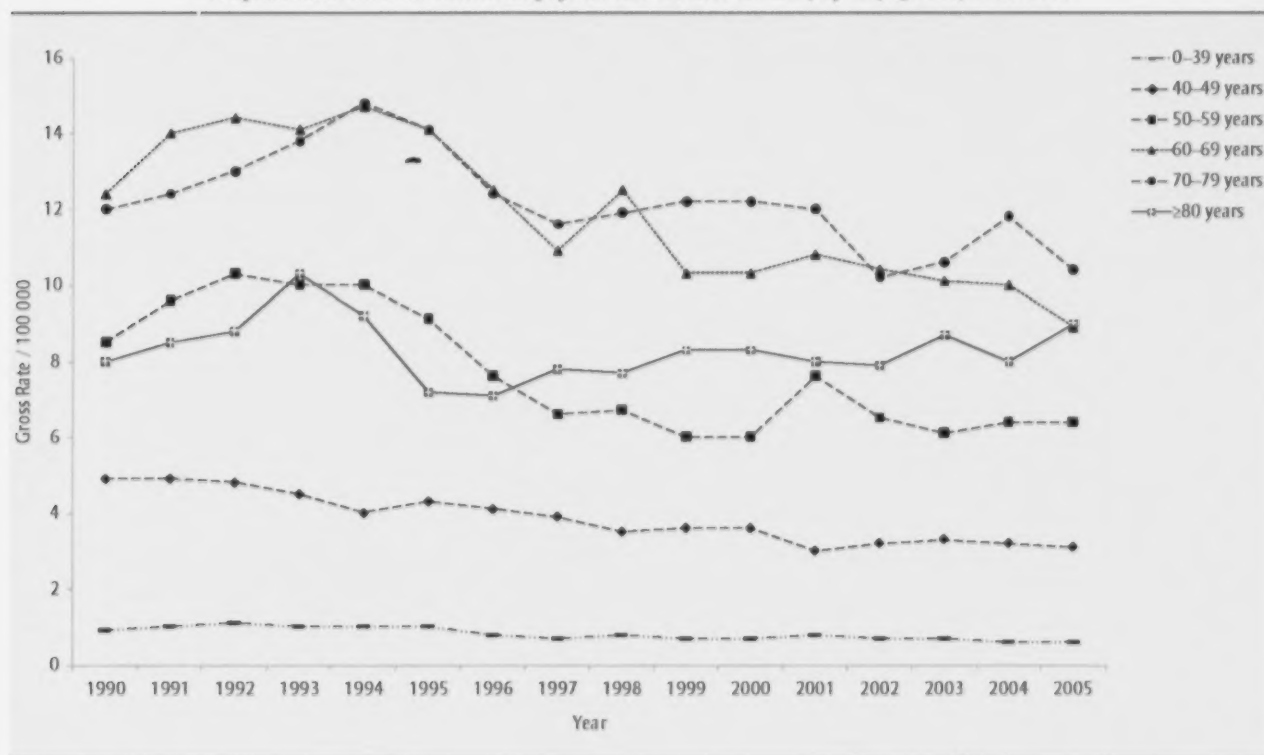
detection and increased screening of populations at high risk of infection. The subsequent decrease in the 2000s could be as a result of duplicate episodes being removed from the RND, which was intensified in 2004 and applied retrospectively and prospectively. The decrease would also be due to prevention activities that target at-risk groups, including injec-

FIGURE 7
Liver cancer and intrahepatic bile duct cancer mortality rates, by sex, Quebec, 1981–2009



^aProvisional data.

FIGURE 8
Hospitalization rates for short-term physical care for liver diseases, by sex, Quebec, 1990–2005



tion drug users. The 2003–2012 public health program for Quebec included among its goals the reduction in HBV and HCV incidence.³⁵ Considering that between 75% and 85% of HCV infections become chronic, 5% to 20% of chronic infections lead to liver cirrhosis, and 1% to 5% of the people with HCV will die as a result of HCV-related cirrhosis or HCC,³⁶ it is clear that comprehensive care measures for CLD patients are relevant and timely. Our results show that CLD and cirrhosis mortality rates fell by 42% between 1981 and 1999. These data are similar to those in Italy, Spain and Portugal, which report reductions of 25% to 30% since the 1970s. These contrast with the cirrhosis mortality rates for England and Scotland, which are between 35% and 112%, possibly because of the less restrictive policies on alcohol use in these countries.⁹ The decreased rates that we observed may be linked to better patient management and to more restrictive policies on sale of and access to alcohol in Canada. After 2000, mortality rates due to liver cirrhosis and ALD fluctuated, more or less reflecting the downward trend shown elsewhere.

Several studies have reported a recent increase in HCC incidence,^{2,32,37–41} and the situation in Quebec is no exception. Between 1998 and 2007, the liver cancer incidence rate in Quebec was 3.7 per 100 000 population (95% CI: 3.5–3.8), ranking second after British Columbia (3.9; 95% CI: 3.7–4.1) among provinces/territories in Canada (data available on request).³⁷ Our results show that this increase began after 1989/1991 and is particularly large for those aged 50 years and older. The liver cancer mortality rate reflects the incidence rate, emphasizing the highly lethal character of this kind of tumour.^{2,32,37–41} The upward trends for liver cancer incidence and mortality in Quebec are similar to those observed in the rest of Canada. According to the Canadian Cancer Society,⁴² between 1997 and 2006 there was a statistically significant change in liver cancer incidence and mortality rates among men (3.1% and 2.2% a year, respectively; such a change is considered statistically significant at 2% or more a year). This increase reflects those reported in the United States, United Kingdom and most European coun-

tries.^{9,39,43} The increase in the liver cancer incidence rate among older people could be linked to a cohort effect, and better management of these patients would probably improve their survival. The observed decrease in the liver cirrhosis mortality rate could be the result of therapeutic advances (e.g. more accessible and effective HBV and HCV antiviral treatments and liver transplants) and could eventually affect the HCC trends.

The decrease in the hospitalization rate for short-term physical care for liver diseases in Quebec in the late 1990s could be linked to the shift toward outpatient care, instituted as a cost-cutting measure, among other reasons.⁴⁴

Despite having results comparable with those of other studies, our study has limitations that should be considered when interpreting the results. It is not possible to determine the distribution of the various CLD risk factors based on our results. The level of access granted for consulting the data sources did not allow for a more detailed breakdown of the

episodes or conditions of interest. The CCHS data have significant limitations for intra- and intercycle comparability, owing to changes in methodology, despite the existence of guidelines for indicator comparability and interpretation.^{35,45,46} Since our observational study is limited to describing trends, a number of aspects related to measuring association and significant differences between the periods and populations studied were not explored. We favoured an overview of the CLD problems studied, drawing links between the determinants and disease states. We believe that this approach, while simple, is nevertheless relevant: it allows for formulation of hypotheses that can be validated in future studies and for highlighting the most important aspects of disease control for decision making.

Acknowledgements

We thank the Institut national de santé publique du Québec and the University Hospital of Bellvitge for their support for the internship that made it possible to complete this study.

There is no conflict of interest or funding source connected with the material presented in this article.

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Deprivation and food access and balance in Saskatoon, Saskatchewan

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This article has been peer reviewed.

Abstract

Introduction: We explored food access and balance in Saskatoon, Saskatchewan, Canada in relation to material and social deprivation.

Methods: We mapped the location of all large supermarkets and fast food retailers in Saskatoon. Supermarket accessibility index scores and food balance scores were compared to material and social deprivation indexes to determine significant associations.

Results: Our results indicate that the poorest access to supermarkets occurred in areas west of the South Saskatchewan River and also in suburban areas around the perimeter of the city. Areas west of the river are some of the most deprived areas in the city. Saskatoon's mean food balance ratio of 2.3 indicates that access favours fast food. However, we did not find a clear pattern or clear socio-economic gradient for most measures.

Conclusion: This study highlights the importance of contextual studies of food access. This study also highlighted a number of other issues that should be explored in the Saskatoon context such as individual-level food consumption patterns, mobility, temporal dimensions of food access and economic access as well as interventions that could improve food access in the city.

Keywords: food access, health, deprivation, socio-economic status

Introduction

Access to healthy, nutritious food is associated with health outcomes at an ecological level.^{1,4} As a result, there is increasing interest in exploring such access within specific geographic areas, and particularly whether disparities in access exist based on factors such as socio-economic status (SES).

Food access and health

Food access is typically measured in terms of spatial proximity to types of food outlets.⁵ Large supermarkets tend to

provide a greater variety of healthy foods at lower prices than do smaller grocery stores or convenience stores.^{6,13} Studies show that, compared with those who live further away, residents who live close to supermarkets are more likely to eat larger quantities of fruit and vegetables and have overall healthier diets and lower levels of obesity.^{6,14,19}

On the other hand, fast food outlets tend to sell nutritionally deficient, processed foods that are high in calories and sodium.²⁰ Some studies have found that living close to fast food outlets is associated with lower quality diets, obesity

and adverse health outcomes such as diabetes and heart disease.^{6,16,21,24} However, other studies have not found an association between proximity to fast food outlets and dietary and health outcomes.^{25,27}

Food balance and health

Food balance is the ratio of the proximity of supermarkets (and hence access to healthy foods) to that of fast food outlets (and access to unhealthy foods). Food balance has been found to correlate with health outcomes.^{28,29} For example, a study in Edmonton, Alberta, found that food balance was significantly associated with obesity, and the more "imbalanced" an area, the more likely that a resident would be obese.²⁹

Food access and socio-economic status

Diet socio-economic gradient, where groups at higher SES consume healthier diets than those living at lower SES, exist internationally as well as in Canada.³⁰ One of the explanations for the diet socio-economic gradient is access: residents of deprived areas have less access to healthy foods compared with residents of more affluent areas.³¹ For low-income residents, access to a vehicle is sometimes limited, which compounds issues of food access.^{13,24,32} A mixed methods study conducted in Saskatoon, Saskatchewan, found that the main issues that affected food-buying practices were owning a vehicle, income and convenience.³³

American studies have found that access to healthier foods is generally worse in

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deprived areas.^{21,34} However, empirical studies from other developed countries have produced mixed results. Studies carried out in Canada, Australia and Scotland have been inconclusive, with some even finding that low-income neighborhoods had better access to healthy foods compared with more affluent neighborhoods.^{8,12,20,35}

Food deserts

Food access research in the past decade has increasingly focused on food deserts. Food deserts are defined by the United States Department of Agriculture as "a low-income census tract where a substantial number or share of residents has low access to a supermarket or large grocery store."³⁶

Whereas research from the United States has found strong support for the existence of food deserts, in Canada findings on food deserts have been less conclusive.³⁴ In fact, a study from Montreal, Quebec, found very few food deserts; conversely, low-income residents had better access to supermarkets than did other residents.⁷ Another study determined that low-income residents in Edmonton, Alberta, had better access to supermarkets, on average;¹⁰ however, the lowest-income residents were also 2.3 times more likely to have a fast food restaurant within a 5- to 10-minute walk compared with those in more affluent neighborhoods.³⁷ Findings similar to those from the United States.^{38,40} A study in London, Ontario, showed that certain low-income neighborhoods were food deserts, although more affluent areas also had poor access to

supermarkets.⁴¹ This suggests that food access research is required on a case-by-case basis to inform local policy and practice.^{31,44}

In this study, we aim to address the following research questions:

- (1) How do food access and balance in Saskatoon vary according to area-level deprivation?
- (2) Does food access and balance follow a socio-economic gradient in Saskatoon?

Methods

Food retailers and fast food outlets

We defined supermarkets as retail grocery outlets that belong to major chains

FIGURE 1
Material deprivation in Saskatoon, Saskatchewan

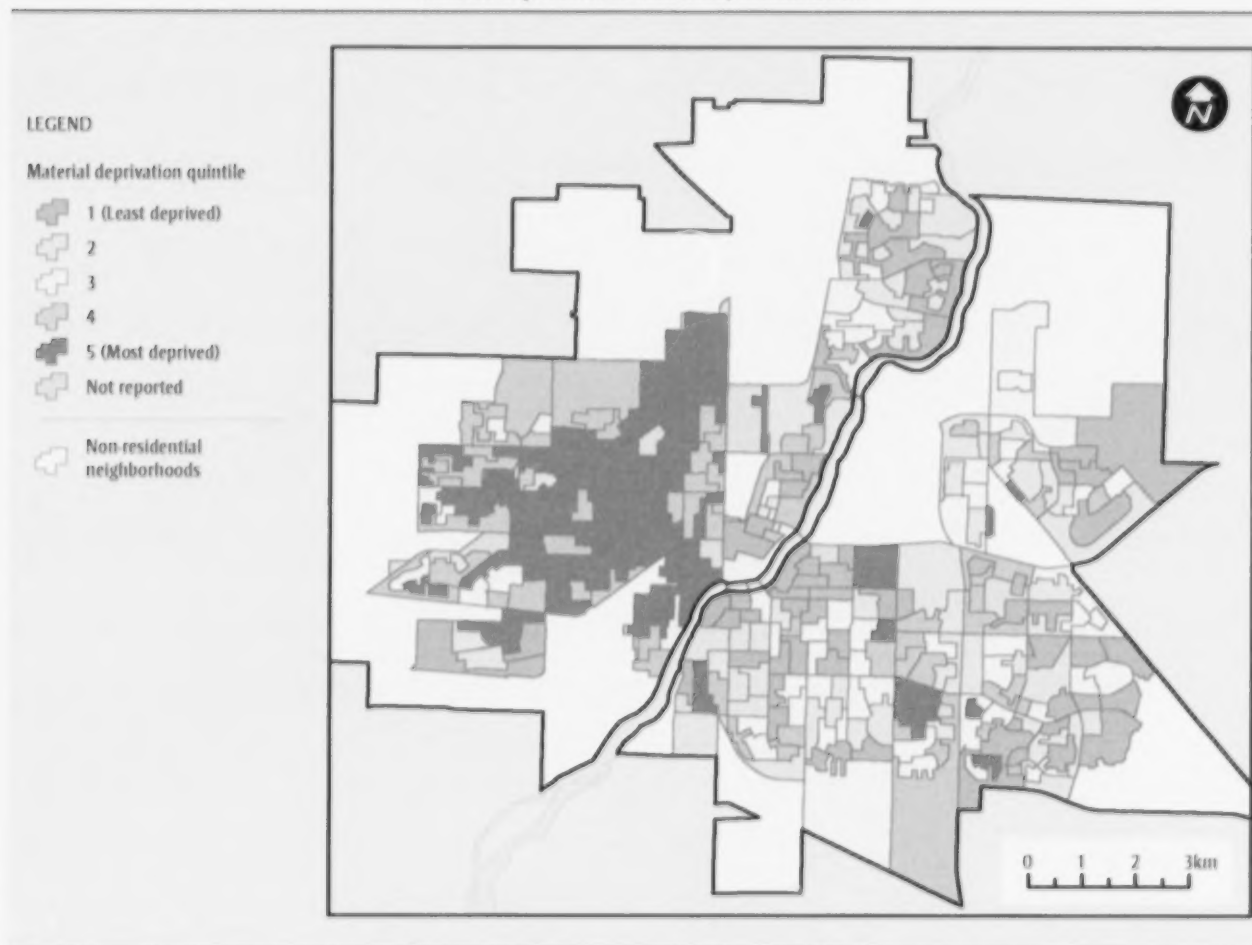
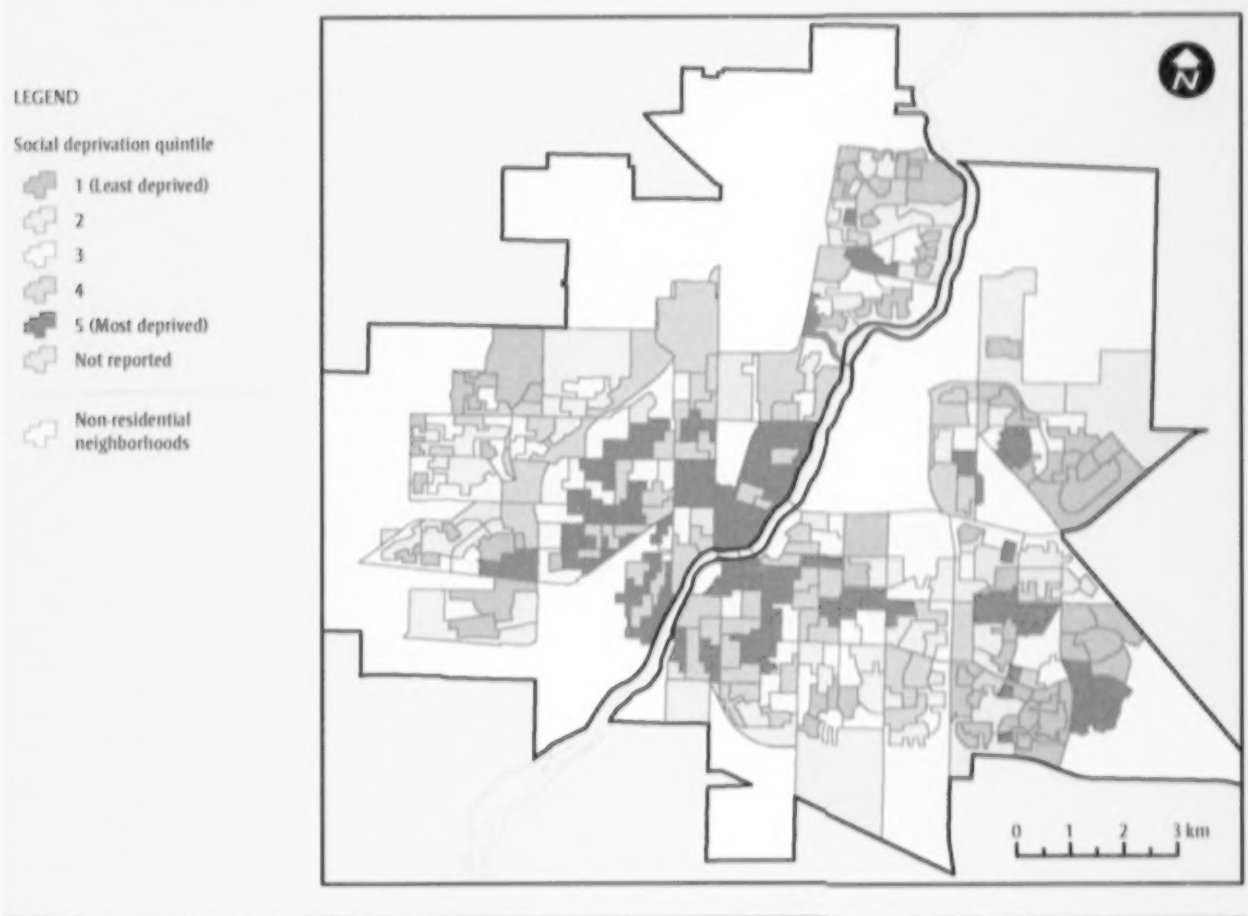


FIGURE 2
Social deprivation in Saskatoon, Saskatchewan



because these tend to consistently offer a greater variety of healthy products at more affordable prices than do smaller and independent supermarkets or other food retailers (e.g. Walmart stores in Saskatoon did not offer many food options at the time of this study).^{7,42} To find the locations of all the supermarkets in Saskatoon, representing access to healthy food ($n = 22$), we used several data sources from 2007 and 2008, including the phone book, company websites and local information. Locations were verified with a Global Position System (GPS) unit, Google Earth and address points from the City of Saskatoon. All locations were geocoded in a database.

We defined fast food outlets as those restaurants where there are no wait staff and patrons pay for their food before receiving it and then themselves carry it to a table or out of the outlet.⁴³ We located all fast food outlets, food courts in malls and convenience stores that served hot food ($n = 120$) using data supplied by the Safe Communities Department, Saskatoon Health Region in August 2008. Locations were then geocoded in the same fashion as were supermarket locations.

Deprivation

We determined area-level deprivation using the deprivation index developed by

the Institut national de santé publique du Québec (INSPQ).⁴⁴ This index measures deprivation at the level of dissemination areas (DAs), the smallest areas for which the Canada Census data are available.⁴⁵ DAs are made up of 1 or more neighbouring blocks that include approximately 400 to 700 residents. The deprivation index includes 2 dimensions, social and material. Social deprivation is composed of 3 variables: proportion of lone parents, proportion of residents living alone and marital status. Material deprivation is measured using the following variables: educational attainment, average income and employment status. For this study, the INSPQ provided us with Saskatoon DA

scores according to both material and social deprivation. The DA scores were calculated based on the 2006 Canadian Census. We assigned DAs to deprivation quintiles, each of which represented approximately 20% of Saskatoon's population. Figures 1 and 2 depict material and social deprivation in Saskatoon. Note that the South Saskatchewan River that runs through Saskatoon demarcates the east and west sides of the city.

Food access and balance

Based on the methodology used by Apparicio et al.⁷ in Montreal, Quebec, we used 3 measures to determine supermarket access: proximity, diversity and variety. These were all calculated at the block level. We calculated proximity by measuring the

Euclidean (i.e. straight-line) distance between the centroid (i.e. geographic centre) of each city block and each supermarket. Diversity was defined as the mean number of supermarkets within 1 kilometre (i.e. walking distance⁷) of the centroid of each block. Variety was defined as the mean distance from each block's centroid to the 3 nearest supermarkets from different chains. Residents with a number of different chains all within close proximity have the greatest choice of brands and prices.⁷

We combined the proximity, diversity and variety measures to create an accessibility index for supermarkets, a novel approach to measuring food accessibility. Proximity scores were classified into tertiles based on all of the scores at the block level. If a block fell into the worst tertile for proximity,

it was given a score of 1; otherwise, it was given a score of 0. Variety scores were also classified into tertiles, and the blocks were scored in the same manner as for proximity. For the diversity measure, an additional score of 1 was added if a block had no supermarkets within a kilometre. The scores for each block were added together to produce an index score, with a maximum score of 3 indicating blocks with the worst accessibility to supermarkets.

Dividing the minimum distance to a supermarket by the minimum distance to a fast food outlet generated a food balance score for each block. A food balance score of 1 indicated that fast food outlets and supermarkets were the same distance from a block's centroid. Areas with a food

FIGURE 3
Proximity to nearest supermarket, Saskatoon, Saskatchewan

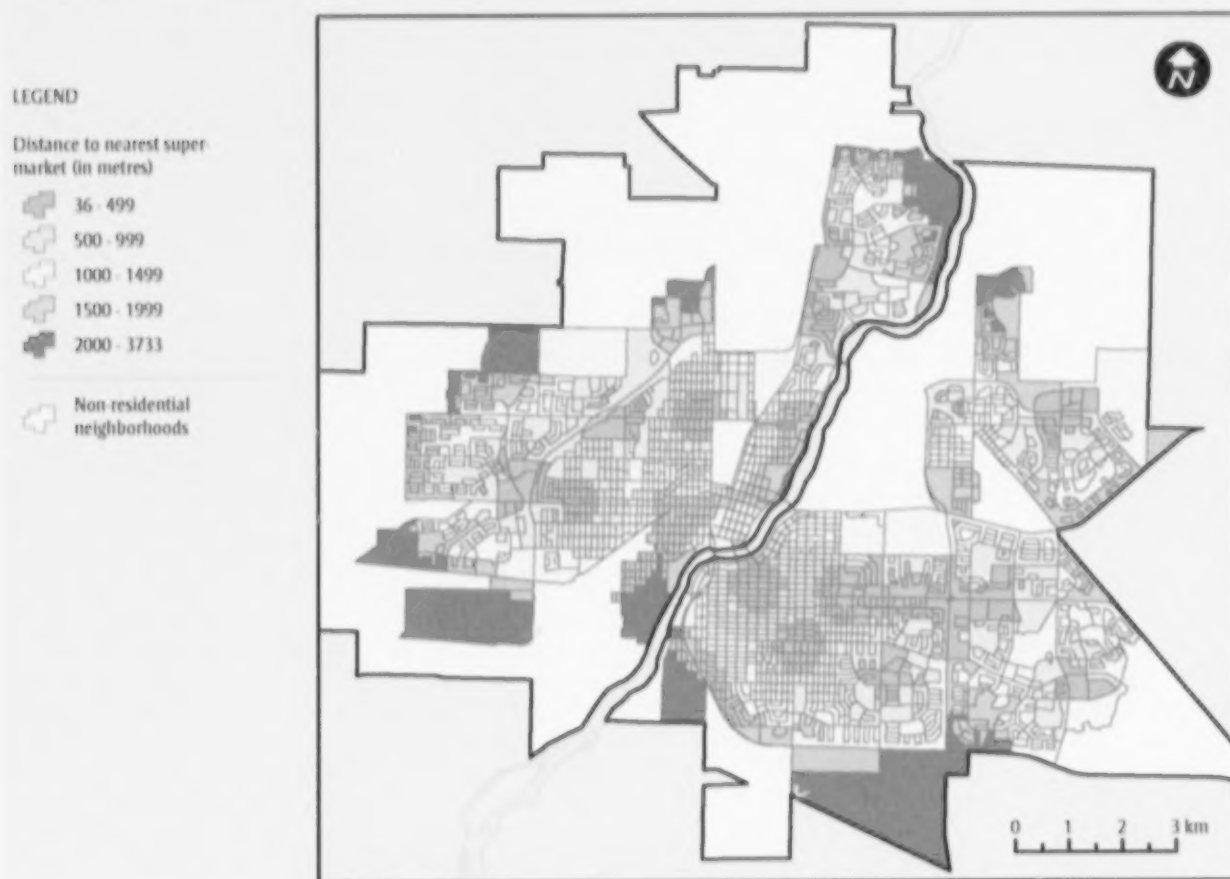


TABLE 1
Descriptive statistics for food access and food balance by 2006 material deprivation quintile, Saskatoon, Saskatchewan

	Quintile				
	1 (least deprived)	2	3	4	5 (most deprived)
Total population, n	39 353	39 418	39 536	39 528	39 144
Supermarket proximity ^a , mean (SD) distance, m	993 (538)	1086 (541)	1085 (607)	1097 (564)	1141 (559)
Population within 1000 m of supermarket, %	49	48	38	33	54
Supermarket diversity ^b , mean (SD)	0.97 (1.08)	0.69 (0.92)	0.90 (1.23)	0.85 (1.30)	0.65 (0.84)
Supermarket variety, mean (SD) distance, m	1580 (596)	1767 (606)	1625 (679)	1620 (590)	1647 (563)
Fast food proximity ^a , mean (SD) distance, m	737 (465)	802 (486)	762 (586)	680 (418)	642 (401)
Population within 1000 m of fast food outlet, %	70	78	67	71	84
Food balance score, mean (SD)	2.0 (3.8)	1.8 (1.9)	2.1 (2.2)	2.3 (3.4)	2.8 (3.7)
Population with food balance score > 2, %	19	24	29	30	36

Abbreviation: SD, standard deviation.

^a Proximity is defined as the Euclidean (i.e. straight line) distance between the centroid (geographic centre) of each city block and each supermarket.

^b Diversity is defined as the mean number of supermarkets within 1 kilometre of the centroid of each block.

^c Variety is defined as the mean distance from each block's centroid to the 3 nearest supermarkets from different chains.

TABLE 2
Descriptive statistics for food access and food balance by 2006 social deprivation quintile, Saskatoon, Saskatchewan

	Quintile				
	1 (least deprived)	2	3	4	5 (most deprived)
Total population, n	39 572	39 690	39 612	39 366	38 739
Supermarket proximity ^a , mean (SD) distance, m	1346 (536)	1145 (629)	978 (486)	1065 (527)	972 (575)
Population within 1000 m of supermarket, %	24	37	48	54	59
Supermarket diversity ^b , mean (SD)	0.38 (0.69)	0.85 (1.22)	0.98 (1.17)	0.79 (1.02)	0.92 (1.13)
Supermarket variety, mean (SD) distance, m	1916 (570)	1714 (686)	1452 (515)	1655 (580)	1588 (617)
Fast food proximity ^a , mean (SD) distance, m	1072 (612)	781 (510)	641 (316)	628 (380)	604 (443)
Population within 1000 m of fast food, %	57	69	75	86	83
Food balance score, mean (SD)	1.7 (1.2)	1.8 (1.3)	2.0 (2.9)	2.7 (3.9)	2.7 (4.1)
Population with food balance score > 2, %	33	21	19	34	32

Abbreviation: SD, standard deviation.

^a Proximity is defined as the Euclidean (i.e. straight line) distance between the centroid (geographic centre) of each city block and each supermarket.

^b Diversity is defined as the mean number of supermarkets within 1 kilometre of the centroid of each block.

^c Variety is defined as the mean distance from each block's centroid to the 3 nearest supermarkets from different chains.

FIGURE 4
Diversity of supermarkets, Saskatoon, Saskatchewan



balance score of less than 1, because the nearest supermarket was closer than the nearest fast food outlet, were considered more "balanced."²³

Finally, because our data were not normally distributed, we explored the associations between food access, food balance, material deprivation and social deprivation using Kruskal-Wallis non-parametric tests. We used post hoc Mann-Whitney U tests with a Bonferroni correction to determine the existence of significant differences between deprivation quintiles.

We also sought to determine areas of concern in terms of food access and

balance. Areas of concern were defined as deprived areas (i.e. areas that fell into quintile 5 for either material or social deprivation) with both poor accessibility to supermarkets (a score of 3 on the accessibility index) and a food balance score in favour of fast food outlets (a food balance score of 2 or more).

Results

Supermarkets

Proximity

Almost half (45%) of the population lived within 1 kilometre of a supermarket. The mean distance of all residential blocks to the nearest supermarket was 1094 metres.

(See Figure 3; more detailed information available on request.)

Proximity differed significantly according to both material deprivation (see Table 1; more information available on request) and social deprivation (see Table 2; more information available on request). For example, for material deprivation, the most deprived blocks (quintile 5) were significantly further away from the nearest supermarket than the least deprived blocks (quintile 1). Proximity tended to decrease as deprivation increased.

However, for social deprivation we found that the least deprived blocks (quintile 1) were significantly further from the nearest supermarket than all other quintiles.

Proximity tended to improve as deprivation increased, although it was very similar in both quintile 3 and quintile 5 blocks.

Diversity

The mean diversity number for Saskatoon was 0.79, meaning that the average resident did not have any supermarkets within a walking distance of 1 kilometre (see Figure 4; more information available on request). Diversity was quite poor in many areas of the city, particularly in the materially and socially deprived areas west of the South Saskatchewan River and those around the perimeter of the city where deprivation was mixed (i.e. blocks in these areas fell into quintiles 1 through 5).

We also found that diversity differed significantly according to material deprivation (see Table 1; more information available on request) and social deprivation (see Table 2; more information available on request). Diversity tended to worsen as material deprivation increased, although quintile 2 blocks did not adhere to this pattern and blocks in quintiles 2 and 5 were both significantly worse in terms of supermarket diversity.

For social deprivation, the least deprived blocks (quintile 1) were significantly worse than all other quintiles.

Variety

The mean distance to the nearest 3 supermarkets from different chains (Figure 5)

was 1657 metres. Similar to the proximity and diversity measures, variety was particularly poor in the more deprived areas west of the South Saskatchewan River and in the suburban areas on the edges of the city where deprivation was mixed.

Variety differed significantly according to both material deprivation and social deprivation. For material deprivation, quintile 2 blocks were significantly further from the nearest 3 supermarkets than quintile 1 blocks (see Table 1). A clear pattern for variety according to material deprivation did not emerge.

When variety is considered according to social deprivation, the least deprived blocks (quintile 1) were significantly

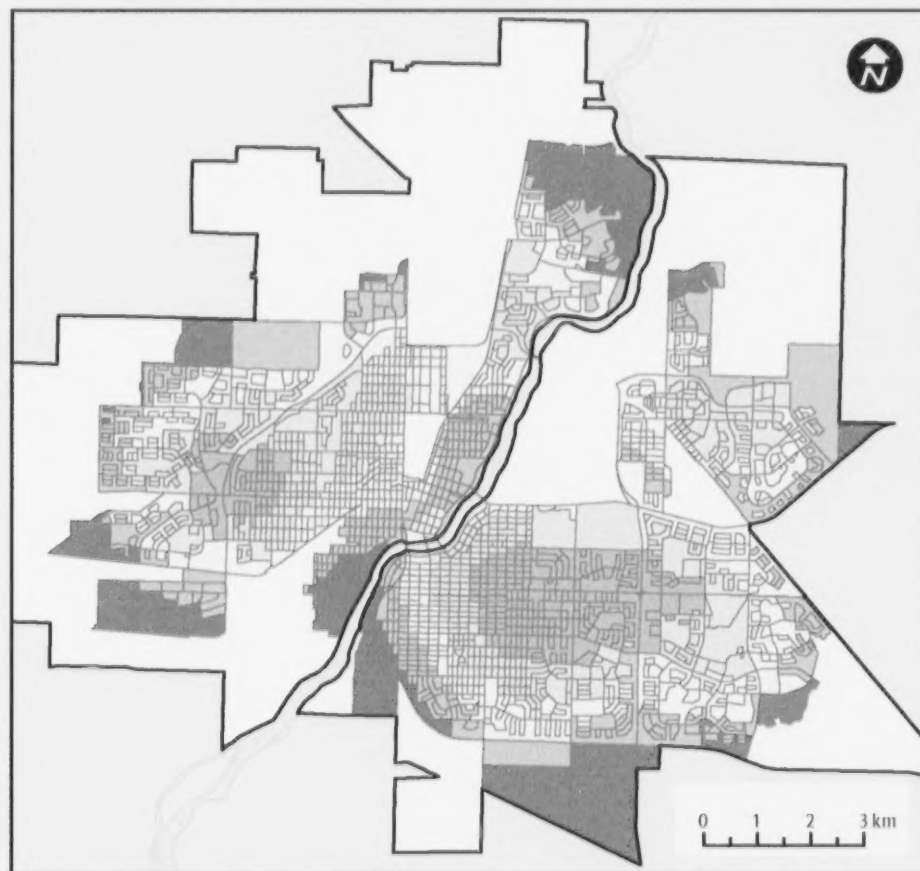
FIGURE 5
Variety of supermarkets, Saskatoon, Saskatchewan

LEGEND

Average distance of 3 supermarkets from different chains (in metres)

- 264 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2499
- 2500 - 4120

Non-residential neighborhoods



further from the nearest 3 supermarkets than all other quintile blocks (see Table 2). A clear pattern also did not exist for variety and social deprivation.

Fast food

Proximity

Three-quarters (74%) of the city's population lived within 1 kilometre of a fast food outlet, and the mean distance to the nearest one was 724 metres (see Figure 6). Generally, blocks with the furthest proximity to fast food outlets were found on the perimeters of the city, where the deprivation was mixed.

Proximity to the nearest fast food outlet differed significantly by material deprivation, with the most deprived blocks

(quintile 5) significantly closer to the nearest fast food outlets than the least deprived blocks (quintile 1). However, proximity to the nearest fast food outlet did not appear to follow a socio-economic gradient (see Table 1).

For social deprivation, the least deprived blocks (quintile 1) were significantly further from the nearest fast food outlet than all other quintile blocks (see Table 2). Proximity to the nearest fast food outlet tended to increase as social deprivation increased.

Food balance

The mean food balance ratio in Saskatoon was 2.3, meaning the average resident

lived more than twice as far from a supermarket as from a fast food retailer (see Figure 7). However, certain areas on the west side that were more materially and socially deprived had a food balance ratio as high as 58.8.

Food balance differed significantly by material deprivation, with some of the most deprived blocks (quintiles 4 and 5) significantly more imbalanced than the least deprived (quintiles 1 and 2) (see Table 1). In general, food balance worsened as material deprivation increased.

Food balance also differed significantly by social deprivation (see Table 2), with blocks in quintiles 4 and 5 significantly more imbalanced than those in quintile 1

FIGURE 6
Proximity to fast food outlets, Saskatoon, Saskatchewan

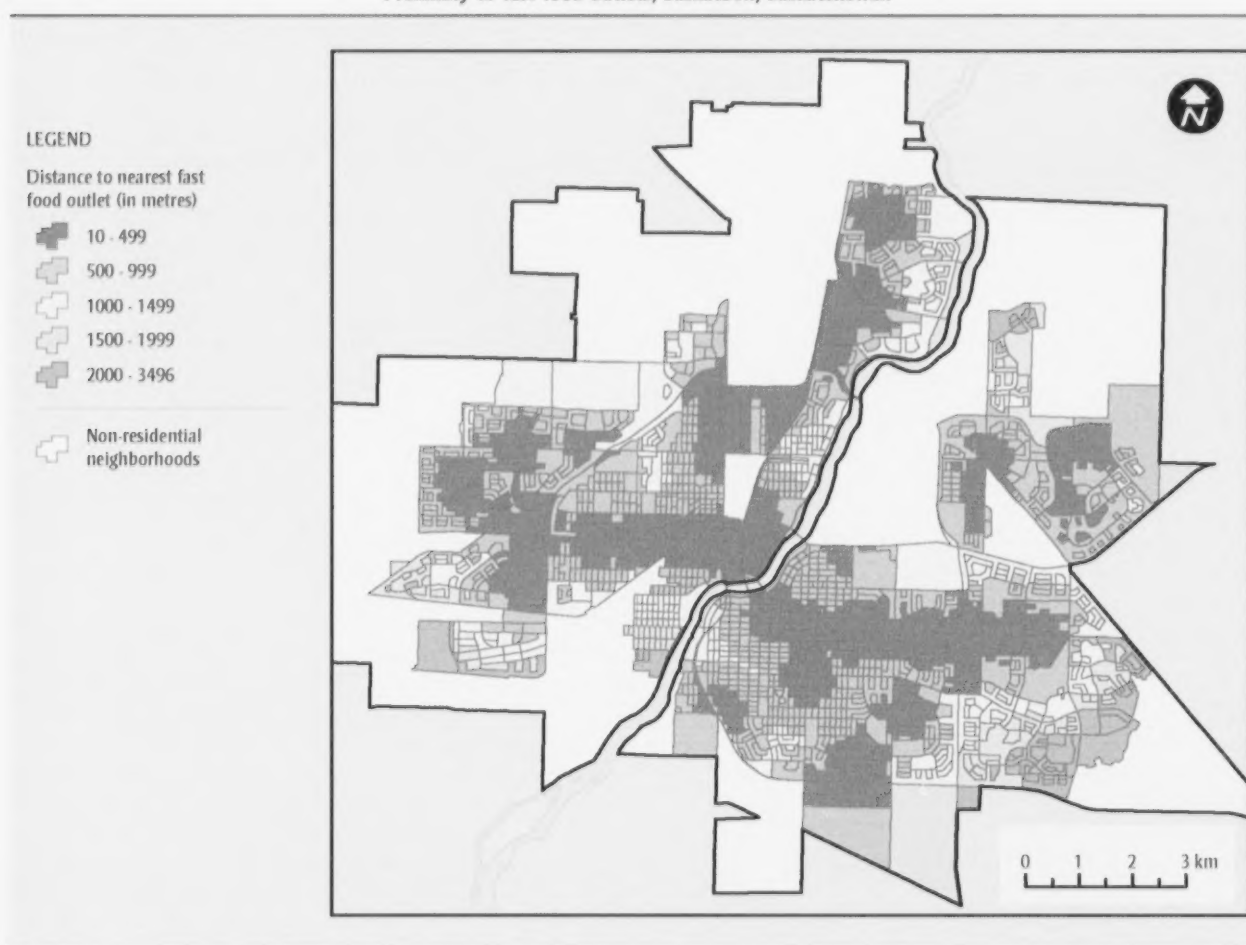
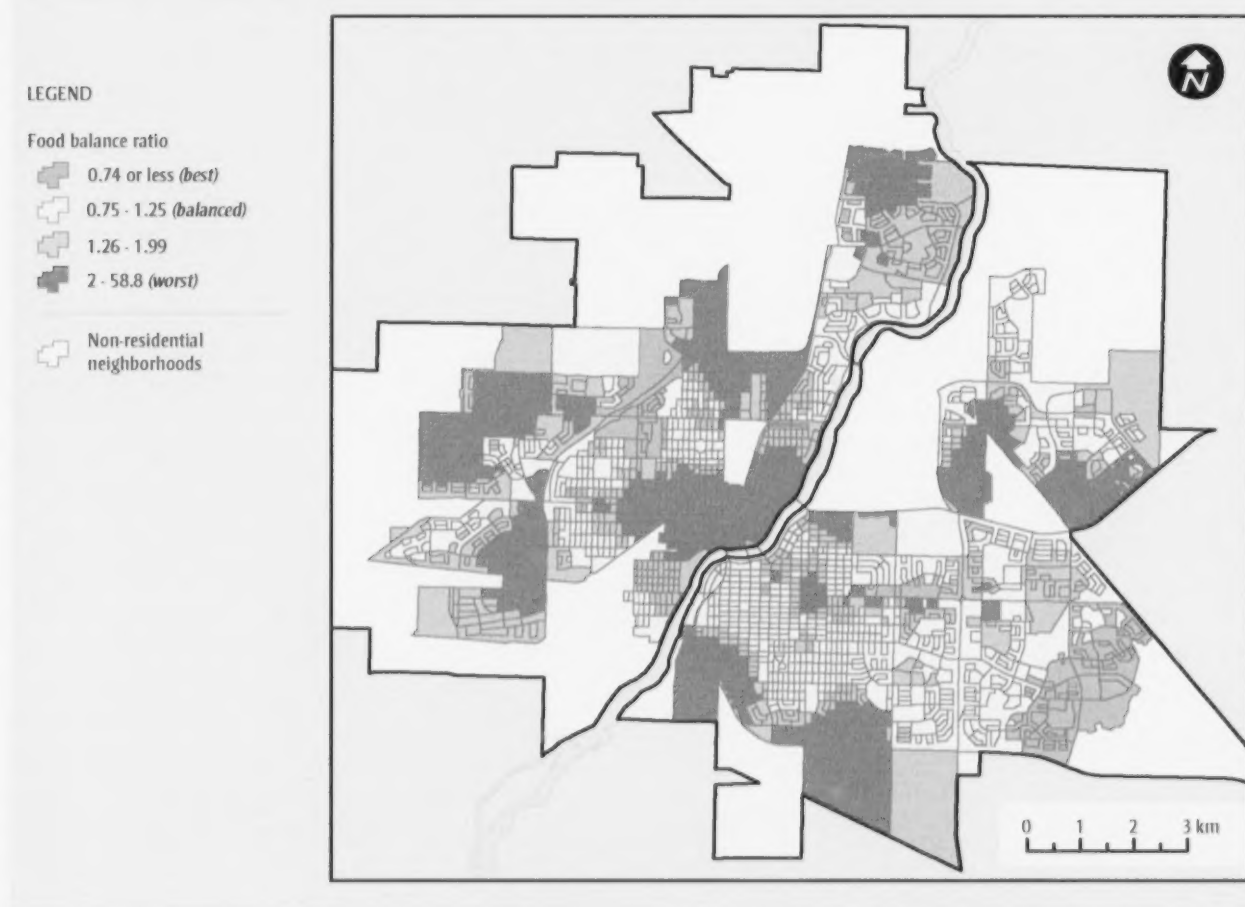


FIGURE 7
Food balance ratio, Saskatoon, Saskatchewan



to 3. Food balance worsened as social deprivation increased.

Areas of concern

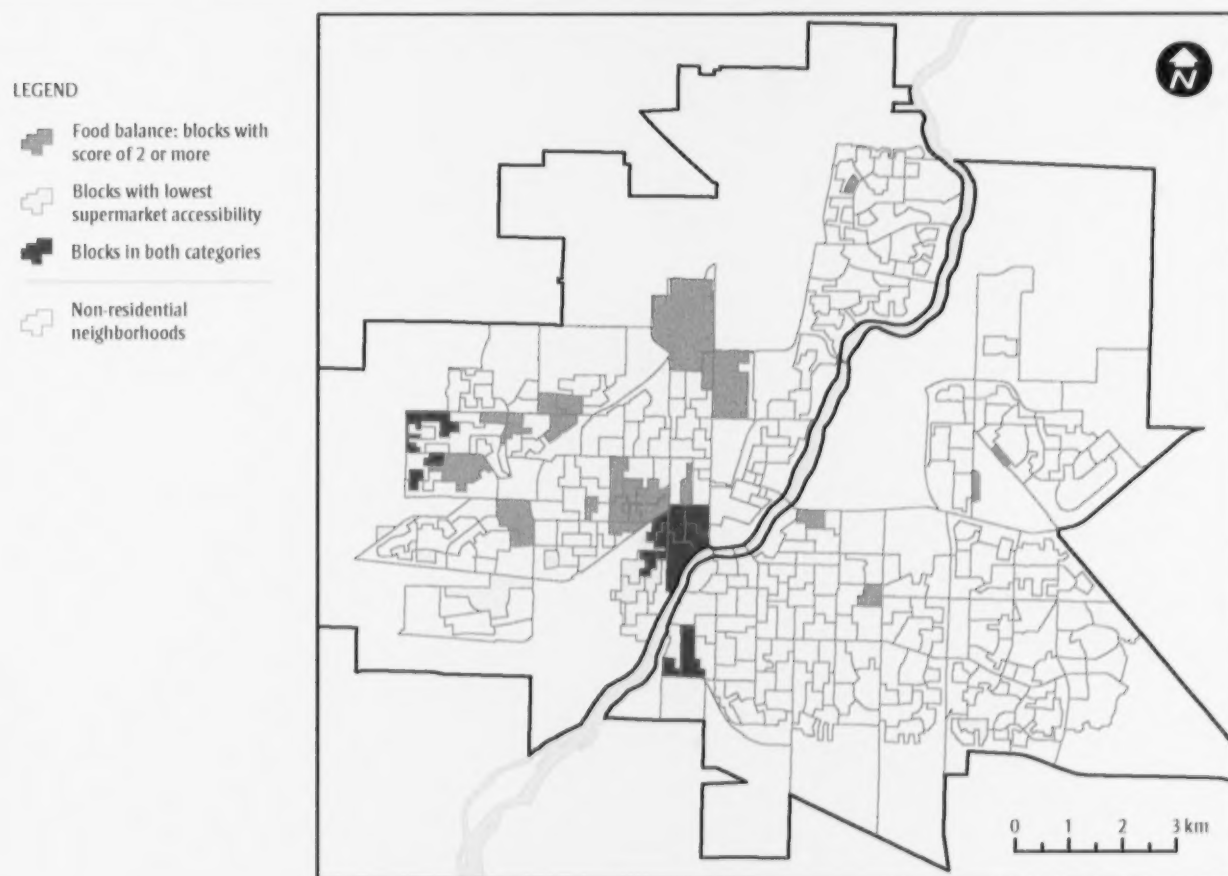
We combined food balance scores and accessibility index scores to identify areas of concern in the most materially or socially deprived (quintile 5) parts of Saskatoon. Figure 8 shows areas of concern according to material deprivation, while Figure 9 shows areas of concern according to social deprivation. According to material deprivation, Saskatoon's largest area of concern was located south of the city and on the west side of the South Saskatchewan River. When looking at social deprivation, the largest area of concern shifted slightly to the north.

Discussion

Our results indicate that access to supermarkets measured in terms of proximity, diversity and variety did not follow a clear pattern. Proximity tended to worsen as material deprivation increased but improved as social deprivation increased. Diversity also tended to worsen as material deprivation increased, although quintile 2 blocks did not conform to this pattern. Diversity according to social deprivation and variety according to either type of deprivation did not adhere to a clear pattern. Other Canadian studies investigating food access and area-level socio-economic status have also not found a clear pattern.^{7,10,12,41}

Three-quarters of Saskatoon residents lived within walking distance (1 kilometre or less) of a fast food outlet, yet less than half lived within walking distance of a supermarket. This may have been due to the big difference between the number of supermarkets ($n = 22$) and the number of fast food outlets ($n = 120$) as assessed in the study; however, this still does not explain why certain more deprived areas on the west side had a food balance ratio as high as 58.8. Fast food proximity did not follow a pattern in terms of material deprivation although it generally increased as social deprivation increased. Food balance generally worsened as material deprivation and social deprivation increased.

FIGURE 8
Materially deprived areas with poor supermarket accessibility and poor food balance, Saskatoon, Saskatchewan



Areas of concern shifted according to whether social deprivation or material deprivation was considered. Previous studies have almost exclusively considered the relationship between food access and material deprivation. However, it is entirely plausible that social deprivation is a separate and distinct construct and requires further study. Individual-level studies should be pursued to determine the precise pathways by which material and social deprivation at an area level affect food access and ultimately health behaviours. In other words, how does access and area-level deprivation affect what type of food is purchased and consumed? Health and place research needs to begin to account more fully for the mechanisms between place-based con-

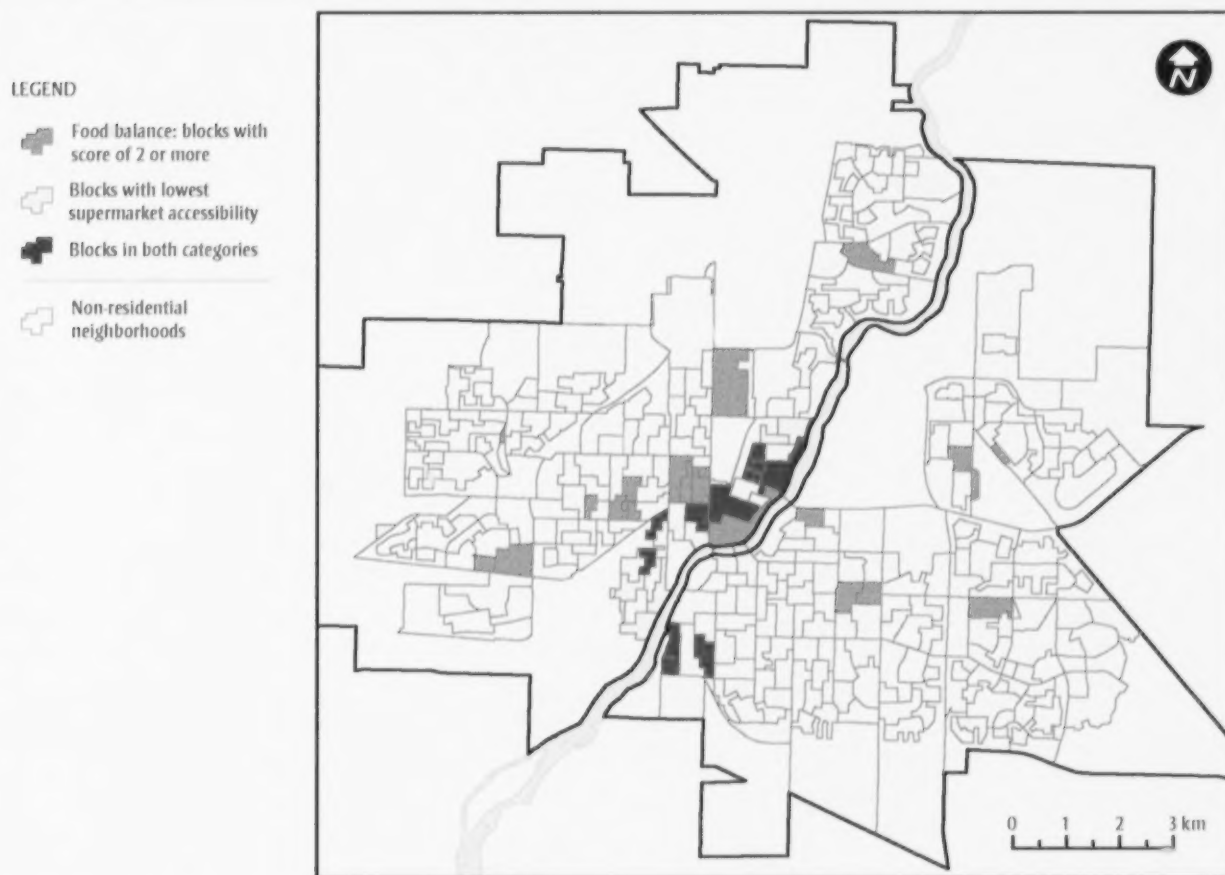
structs and individual health behaviours such as healthy food consumption.^{13,27}

Our study is a unique contribution to the literature in terms of methodology: the majority of food access studies have used only one measure of access,^{14,46,47} and some have used more than one measure of access,^{7,48} but very few have combined an accessibility score and a food balance score.²³ Our food balance score was similar to the Retail Food Environment Index used in a study in Edmonton, Alberta, that measured the number of fast food retailers plus the number of convenience stores divided by the number of grocery stores and specialty food stores all within a given radius.²⁹ If we had used the Retail Food Environment Index in the Saskatoon con-

text, it is likely that food imbalance scores would have been even higher because convenience stores far outnumber specialty food stores in Saskatoon.

Another unique contribution of our study was the use of a deprivation index that covers both material and social dimensions. As noted earlier, food access has been primarily studied in relation to material deprivation, and the implications of social deprivation have been understudied. Since the INSPQ deprivation index has been used to assess health status and outcomes in major metropolitan areas in Canada,⁴⁹ our methodology could be easily applied to other Canadian cities to facilitate cross-jurisdictional comparisons, if national cut-offs are used (we used local cut-offs in this study).

FIGURE 9
Socially deprived areas with poor supermarket accessibility and poor food balance, Saskatoon, Saskatchewan



Limitations

While our study used innovative approaches to determine the associations between food access and food balance and deprivation, some limitations should be noted. First, while we considered many dimensions of access, our study did not account for economic access, for example, food prices being generally lower for unhealthier foods.⁵⁰ Future studies should consider the interplay between access and food prices and how these are associated with both area-level deprivation and individual-level consumption patterns.

Our study also did not account for mobility. In other words, people do not always access food in the areas where they

live.²⁷ For instance, a recent study in Detroit, United States, found that individuals' activity spaces (i.e. the space where individuals conduct day-to-day activities) varied, often according to SES.⁵¹

Another limitation of our study was its ecological nature. Access at the area level does not guarantee that all individuals within that area are using the same food outlets or, more importantly, consuming the same food. As already noted, future studies should consider the interplay between area-level measures such as food access and individual-level measures such as food consumption patterns and health outcomes. Individual food consumption patterns would also shed light on whether individuals are selecting healthy options at

supermarkets or unhealthy options at fast food outlets. This would be important to study since some fast food outlets are trying to market healthier options.

Our study did not account for trends over time. Even though some of our data was from different years (e.g. 2006–2008), this study was cross-sectional. Similar studies have also been almost entirely cross-sectional, yet the relationship between environment and health is inherently temporal.⁵² Longitudinal studies should be considered as a further innovation in this area of research, with access measured and mapped over time.

Finally, future studies should expand the inclusion criteria for food outlets. We did

not include smaller and independent supermarkets in this analysis because they tend to be more expensive and stock less of a variety than do larger supermarkets. However, in certain areas they may be the nearest source of healthy foods. In addition, even though we included convenience stores that sell hot food, all convenience stores could be included in future studies given results from other studies. For example, an American study found that the greater the number of convenience stores in an area, the greater the probability of higher body mass indexes.⁵³ Other studies have also included restaurants other than fast food outlets.⁶

Although there were limitations, this study does suggest that policy and program interventions are required to improve food access in the city, particularly in deprived areas west of the South Saskatchewan River. One such intervention that should address the areas of concern found in this study is the Station 20 West community centre situated south-west of the South Saskatchewan River. The centre will include a not-for-profit grocery store that stocks affordable, healthy food. Other interventions that could be considered include the following: including quality food retail outlets as part of the planning criteria for every new neighborhood developed in the city;⁵⁴ offering taxation incentives for the provision of food services in disadvantaged areas;⁵⁴ developing neighborhood produce markets;⁵⁴ encouraging urban agriculture;⁵⁵ and providing specialized transportation services to supermarkets or delivery programs from supermarkets.^{9,10} Evaluation of interventions is a key area that requires further exploration; although numerous interventions dealing with food access and balance in Canada have been proposed, there has been little research on the implementation and effectiveness of these interventions.²⁹

Conclusion

Our study found that food access and balance varied according to material and social deprivation in Saskatoon. Some food access measures seemed to follow a socio-economic gradient (e.g. proximity to

supermarkets according to material deprivation; food balance worsened as material and social deprivation increased). However, other measures of access did not follow a clear pattern. These results highlight the importance of contextual studies of food access since different patterns have emerged between and within countries and cities. This study also highlighted a number of other issues that should be explored in the Saskatoon context, such as individual-level food consumption patterns, mobility, temporal dimensions of food access and economic access.

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Identifying cases of congestive heart failure from administrative data: a validation study using primary care patient records

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This article has been peer reviewed.

Abstract

Introduction: To determine if using a combination of hospital administrative data and ambulatory care physician billings can accurately identify patients with congestive heart failure (CHF), we tested 9 algorithms for identifying individuals with CHF from administrative data.

Methods: The validation cohort against which the 9 algorithms were tested combined data from a random sample of adult patients from EMRALD, an electronic medical record database of primary care physicians in Ontario, Canada, and data collected in 2004/05 from a random sample of primary care patients for a study of hypertension. Algorithms were evaluated on sensitivity, specificity, positive predictive value, area under the curve on the ROC graph and the combination of likelihood ratio positive and negative.

Results: We found that that one hospital record or one physician billing followed by a second record from either source within one year had the best result, with a sensitivity of 84.8% and a specificity of 97.0%.

Conclusion: Population prevalence of CHF can be accurately measured using combined administrative data from hospitalization and ambulatory care.

Keywords: congestive heart failure, validation studies, epidemiologic methods, population prevalence

Introduction

Hospital discharge abstracts^{1,2} have traditionally been used to identify those patients with congestive heart failure (CHF) who present to hospital or who are hospitalized for other conditions but have CHF listed as a co-morbidity. In their recent systematic review of validation studies of algorithms to identify CHF from administrative data, Saczynski et al.³ found this to be true for 25 of 35 studies listed.

Compared with hospital records, the use of hospital discharge abstracts to identify patients with CHF has been found to be highly accurate.^{4,5} However, with improvements in treatment and decreases in hospital resources, more patients with heart failure are being successfully managed in the community. As a result, they may never show up in the hospital discharge data or else not until their disease is in the advanced stages. Thus, using hospital data alone will probably underestimate the incidence and prevalence of CHF.

Validated algorithms using combinations of physician billing data and hospital discharge abstracts have been developed to identify patients with chronic disease conditions that do not necessarily require hospitalization, for example, hypertension, diabetes, ischemic heart disease and asthma.⁶⁻⁹ However, of the 35 studies listed in the systematic review conducted by Saczynski et al.,³ only 9 used data from both hospital discharges and ambulatory claims data, and only 2 were also population-based, although the population was still limited to patients enrolled in a large managed-care organization.^{10,11}

The purpose of our study was to determine the most suitable algorithm of administrative data to identify patients with CHF in Ontario, Canada. We used information within primary care physician outpatient electronic medical records (EMRs) and fee-for-service primary care physician charts to assess the validity and reliability of various combinations of physician billing data and hospital discharge data.

Methods

Data sources

Validation cohort

The validation cohort used in this study comprised data from two sources. The first was collected through the Canadian Cardiovascular Outcomes Research Team (CCORT) from 17 physicians using Practice Solutions® Electronic Medical

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Records (EMR) that contributed their patient records into the Electronic Medical Record Administrative data Linked Database (EMRALD). Physicians participating in this study had to have been using the EMR for a minimum of 2 years in order to have an EMR populated with a full practice of patients. Data from the EMR were extracted from June to December of 2007, anonymized, encrypted and then transferred electronically to the Institute for Clinical Evaluative Sciences (ICES) in a secure fashion. ICES is a prescribed entity under the Ontario Personal Health Information Protection Act, which means the organization can receive and use health information, without consent, for analysis and to compile statistical information about the Ontario health care system. Data can be collected from a variety of sources, including the Ministry of Health and Long-Term Care, hospitals and physicians, provided ICES has in place policies, practices and procedures that have been audited and approved by the Information and Privacy Commissioner of Ontario. The data used in this study were handled as per ICES' standard operating procedures to preserve patient privacy and confidentiality.

The total eligible EMR patient population consisted of 19 376 active adult patients aged 20 years or more. "Active" was defined as rostered to the participating physician, having at least 2 visits in the last 3 years and a valid Ontario Health Insurance Plan (OHIP) card. Data were abstracted from a 5% random sample of patient charts ($n=969$) by three trained abstractors. Inter-observer reliability calculated on global agreement on the presence or absence of CHF was very good (kappa score [κ] > 0.80).

The second data source was a random sample of patient charts abstracted from 76 fee-for-service family physician practices between December 2004 and August 2005 for validation of an administrative data-based algorithm to detect cases of hypertension.⁶ In this study, charts were abstracted from a random sample of all eligible patients ($n=2472$). Eligible patients were aged 38 years or more, regular and current patients of the practice with at least 2 visits during the previous 3

years and an OHIP health card number. Two abstractors abstracted the charts, once again with very good inter-observer reliability, and again calculated on the overall status of the presence or absence of CHF ($\kappa > 0.80$).

We identified patients with CHF from both data sources in a similar manner: the trained chart abstractors reviewed all available entries in the EMR or in the previous three years in the patient charts. Each entry was scored as to whether it indicated "definite" CHF, "possible" CHF, a family history of CHF or no CHF. A "definite" CHF entry meant there was explicit physician documentation stating that the patient had CHF or one or more of the following synonyms: biventricular failure, cardiac decompensation, cardiac failure, heart failure (right or left), pump failure, ventricular failure or wet lungs. Diagnostic test findings consistent with CHF were classified as "possible" CHF. If there was no mention of CHF or any of its synonyms, patients were considered as having no CHF. The resulting abstraction classification for each patient was tabulated and patients were considered to have CHF only if one or more entries denoted definite CHF.

To ensure consistency between the two data sources, only individuals from the EMR cohort aged 38 years or more were included. We did not expect this to introduce any bias as the EMR sample was a simple random sample from each physician practice. To enable analysis of these data, each patient's health card number was encrypted, yielding a unique identification number that could be linked to the Ontario administrative data holdings housed at ICES.

Administrative data sources

The administrative data sources used to detect cases of CHF in the population included the hospital discharge abstract database (DAD) and the same-day surgery database (SDS), maintained by the Canadian Institute for Health Information (CIHI), and the OHIP database of physician fee-for-service billings or shadow-billings. The DAD and SDS classify pre-2002 diagnoses using codes from the *International Classification of Diseases*,

9th Revision (ICD-9) and later ones using the 10th Revision (ICD-10); the OHIP database uses a modified version of ICD-8. The OHIP physician billing data records over 95% of office-based primary care physician encounters for Ontario residents. A diagnostic code for CHF in the OHIP physician billing database or in the CIHI hospitalization databases (DAD or SDS) was the most responsible diagnosis; otherwise, a co-morbid condition was taken as positively indicating CHF.

Diagnostic codes used to define CHF

The diagnostic codes used to define CHF vary considerably. In the ICD-9 schema, CHF is most often defined as ICD-9 428. Lee et al.⁴ validated ICD-9 428 against two sets of clinical criteria using information from patients' hospital records and found it to be highly predictive. In turn, Vermeulen et al.¹³ compared the performance of ICD-9 428 and ICD-10 I50 and found them to be comparable. These two results address the question, "Do ICD-9 428 or ICD-10 I50 correctly identify cases of heart failure?" However, they do not speak to the issue of whether these codes are sufficient to detect *all* cases of CHF. Studies from other jurisdictions^{5,14,15} have used a broader range of diagnostic codes to identify cases of CHF from administrative data. We decided to compare two CHF definitions: a narrow definition that uses only ICD-9 428 and ICD-10 I500, I501 and I509, and a broader definition that also includes the codes for cardiomyopathy (ICD-9 425; ICD-10 I42) and pulmonary edema (ICD-9 514, 518.4; ICD-10 J81).

Algorithms tested

We tested 9 algorithms, which varied according to the data sources used and the length of time of follow-up. The performance of the various administrative data algorithms was evaluated against the manually abstracted CHF status from the patient's chart/EMR. These algorithms can be broadly divided into 3 groups. The first, algorithms 1 to 3, require only one record for a diagnosis of CHF but test the use of different data sources. Algorithms 4 to 6 require either one inpatient record or one ambulatory care record plus an additional record from

either source within a specific time period that varies between 1, 2 or 3 years. The third group, algorithms 7 to 9, are similar to 4 to 6 but use only ambulatory care data and require two ambulatory care records within 1, 2 or 3 years of follow-up (see Table 1).

We evaluated each algorithm with respect to its sensitivity, specificity and positive predictive value (PPV) and calculated 95% confidence intervals (CIs) using the binomial approximation method. All analyses were conducted using SAS version 9.2 (SAS Institute, Cary, NC, US).

We also estimated two summary measures, the receiver operating characteristics (ROC) curve and the likelihood ratio positive and negative (LR+ and LR-) to provide additional diagnostics. The ROC curve, originally developed to evaluate signal detection by radar operators, plots sensitivity (true positives) against 1 minus specificity (false positives). The closer the area under the curve (AUC) is to 1.00, the better the test.

The likelihood ratio graph plots the LR+, which is the ratio of sensitivity (the true positive rate) to 1 minus specificity (the false positive rate), against the LR-, which is the ratio of the false negative rate (1 - sensitivity) to the true negative rate (specificity).¹⁶ The LR+ measures the ability of the test to include those who have the condition while the LR- measures the ability to rule out those without the condition. Using the cut points first suggested by Jaeschke et al.,¹⁷ tests with

an LR+ greater than 10 and an LR- less than 0.1 are considered very useful, those with an LR+ between 5 and 10 and an LR- between 0.1 and 0.2 are considered moderately useful and those with an LR+ between 2 and 5 and an LR- between 0.2 and 0.5 are only somewhat useful. Tests with an LR+ less than 2 and an LR- more than 0.5 are of no use.

Results

The combined validation cohort comprised 2338 patients, with 99 definite for CHF according to their chart or EMR and 2239 without the condition (prevalence = 4.2%).

The age and gender distribution of patients in the validation cohort was similar to that of the 2006 Ontario population¹⁸ aged 38 years and older with a slight over-representation of women (56% in the cohort compared with 52% in the general population) and of individuals aged 65 years and older (32% in the cohort as opposed to 26% in the Ontario population aged 38 years and older). This was to be expected as our validation cohort was composed of individuals who make regular visits to a family physician, and both women and seniors are known to be more likely to visit a physician.¹⁹ The average age of our active adult cohort was 57.9 years, slightly higher than the average age (56.1 years) of Ontarian adults aged 38 years or older.

Taking a broad look across the three groups of algorithms (see Table 2), two

things become evident. The first is that follow-up time makes very little difference. The results for algorithms 4, 5 and 6 are nearly identical, and there is also very little difference in the performance of 7, 8 and 9. What appears to make more of a difference is the choice of data sources. For example, the sensitivity of algorithms 4, 5 or 6, which use both hospitalization and ambulatory care data, is at least 10 percentage points higher than that of algorithms 7, 8 or 9, which use only ambulatory care data, and 20 percentage points higher than hospital data alone.

The impact of data source on algorithm performance becomes particularly evident in the results for algorithms 1, 2 and 3. Algorithm 3, which requires only one record from any source for a diagnosis of CHF, had the highest sensitivity at 89.9% but the lowest specificity (93.5%) and the poorest PPV (38.0%). Inpatient data alone (algorithm 1) was the least sensitive, detecting only 60.6% of CHF cases, but it also had the highest specificity at 98.6% and the highest PPV (65.9%; Table 2). Negative predictive value (data not shown) was uniformly high, ranging from 99.6% for algorithm 3 to 98.2% for algorithm 1.

Turning to the results of the summary measures, it is interesting to note that the most useful algorithms are again those that use both ambulatory and hospitalization data. All the algorithms that use only one type of data, be it hospital or ambulatory care, are lower on the ROC curve or in the "somewhat useful" area of the LR graph (Figure 1). Looking at the ROC curve (Figure 2), the performances of algorithm 3 followed by 4, 5 and 6 are the best of the nine. The AUC for algorithm 3 was 0.917 and for 4, 5 and 6 was 0.909. When comparing the LR results (Figure 2), algorithms 3, 4, 5, 6 and 2 all fall within the "moderately useful" section of the graph, with algorithm 3 closest to the "very useful" section and algorithm 2 the furthest.

Selecting the best algorithm

The final choice for the best algorithm to identify CHF cases is between algorithms 3 and 4 (5 and 6 having been dropped from

TABLE 1
Administrative data algorithms tested against manually abstracted CHF status from the patient's chart or EMR

Algorithm	Description
1	1 hospital record
2	1 ambulatory care record
3	1 hospital or ambulatory care record
4	1 hospital record alone OR 1 ambulatory care record followed by another record in 1 year
5	1 hospital record alone OR 1 ambulatory care record followed by another record in 2 years
6	1 hospital record alone or 1 ambulatory care record followed by another record in 3 years
7	2 ambulatory care records in 1 year
8	2 ambulatory care records in 2 years
9	2 ambulatory care records in 3 years

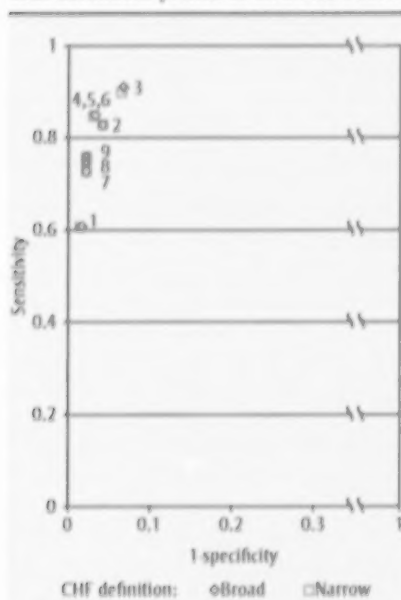
Abbreviations: EMR, electronic medical record; CHF, congestive heart failure.

TABLE 2
Sensitivity, specificity and PPV of nine different algorithms used to estimate CHF status from manually abstracted primary care physician data and administrative data

Algorithm number	Description	CHF definition	Sensitivity, % (95% CI)	Specificity, % (95% CI)	PPV, % (95% CI)
1	1 CHH record	Narrow	60.6 (50.8, 70.4)	98.6 (98.1, 99.1)	65.9 (56.0, 75.9)
		Broad	60.6 (50.8, 70.4)	98.3 (97.8, 98.8)	61.2 (51.4, 71.0)
2	1 OHIP claim	Narrow	82.8 (75.3, 90.4)	95.8 (94.9, 96.6)	46.3 (51.4, 71.0)
		Broad	82.8 (75.3, 90.4)	95.8 (94.9, 96.6)	46.3 (38.9, 53.7)
3	1 CHH or OHIP claim	Narrow	89.9 (83.9, 95.9)	93.5 (92.5, 94.5)	38.0 (31.8, 44.3)
		Broad	90.9 (85.1, 96.7)	93.3 (92.3, 94.4)	37.7 (31.5, 43.8)
4	1 CHH or 1 OHIP + 2nd claim (any source) in 1 year	Narrow	84.8 (77.7, 92.0)	97.0 (96.3, 97.7)	55.6 (47.6, 63.6)
		Broad	84.8 (77.7, 92.0)	96.8 (96.1, 97.5)	53.8 (45.9, 61.8)
5	1 CHH or 1 OHIP + 2nd claim (any source) in 2 years	Narrow	84.8 (77.7, 92.0)	97.0 (96.1, 97.5)	55.3 (47.3, 63.3)
		Broad	84.8 (77.7, 92.0)	96.7 (96.0, 97.5)	53.5 (45.6, 61.4)
6	1 CHH or 1 OHIP + 2nd claim (any source) in 3 years	Narrow	84.8 (77.7, 92.0)	96.9 (96.2, 97.6)	54.9 (46.9, 62.9)
		Broad	84.8 (77.7, 92.0)	96.7 (96.0, 97.4)	53.2 (45.0, 61.0)
7	2 OHIP/ NACRS claims in 1 year	Narrow	72.7 (63.8, 81.7)	97.8 (97.2, 98.4)	59.5 (50.6, 68.4)
		Broad	72.7 (63.8, 81.7)	97.8 (97.2, 98.4)	59.5 (50.6, 68.4)
8	2 OHIP/ NACRS claims in 2 years	Narrow	74.8 (66.0, 83.5)	97.8 (97.2, 98.4)	60.2 (51.4, 68.9)
		Broad	74.8 (66.0, 83.5)	97.8 (97.2, 98.4)	60.2 (51.4, 68.9)
9	2 OHIP/ NACRS claims in 3 years	Narrow	75.8 (67.2, 84.4)	97.8 (97.2, 98.4)	60.0 (51.3, 68.7)
		Broad	75.8 (67.2, 84.4)	97.8 (97.2, 98.4)	60.0 (51.3, 68.7)

Abbreviations: CI, confidence interval; CHF, congestive heart failure; CHH, Canadian Institute for Health Information; NACRS, National Ambulatory Care Reporting System; OHIP, Ontario Health Insurance Plan; PPV, positive predictive value.

FIGURE 1
Results for nine algorithms to detect congestive heart failure (CHF) cases from administrative data using two CHF diagnostic code definitions plotted as on an ROC curve



Abbreviations: CHF, congestive heart failure; ROC, receiver operating characteristics.

consideration because their additional follow-up time is unnecessary). Based on the results of the summary measures, algorithm 3 appears superior. What's more, if this test were being used in a clinical setting it usually *would* be the best, primarily because its high sensitivity minimizes the number of cases that would be missed. However, for population-based reporting the false positive rate is a more important consideration. Because this algorithm will be used for an entire population, not just self-selected patients visiting a physician, and because the condition is relatively rare, even a small drop in specificity can translate into a large number of false positive cases. False positives, in turn, lead to research results that are biased to the null. As a result, algorithm 3 is ruled out by its relatively low specificity and LR+. The best algorithm for identifying cases of CHF is therefore algorithm 4.

In addition to testing the different algorithms, we also tested two different definitions of CHF. In most cases there

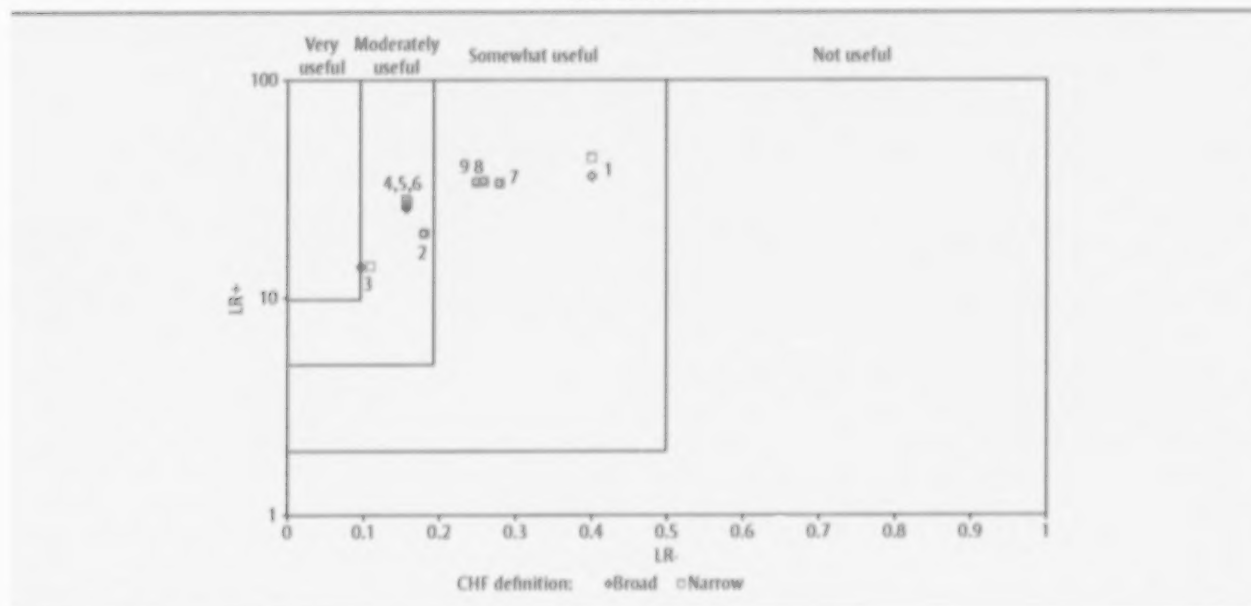
was little difference in the results. Where there was a difference, the narrow definition performed better, mainly because the broader definition tended to increase the number of false positives (Table 3).

Discussion

In this study, we tested nine different administrative data algorithms, which varied according to the number of records needed for a CHF diagnosis, the length of follow-up time allowed and the data sources used. We also tested two different sets of diagnostic codes used for identifying individuals with CHF in administrative data.

Previous studies that compared information in hospital charts with discharge data have found the coding of CHF diagnoses to be very accurate when tested against clinical criteria such as Framingham or Boston.^{4,5} However, we found that using hospital data alone to estimate CHF prevalence is insufficient and may fail to capture 40% of positive cases. This suggests that a sub-

FIGURE 2
Likelihood ratios (LR) for nine algorithms to detect congestive heart failure (CHF) cases from administrative data using two CHF diagnostic code definitions



Abbreviation: LR, likelihood ratio.

stantial proportion of Ontarians with CHF are being diagnosed and managed outside of hospital.

Another general finding is that basing a CHF diagnosis on only a single record with a CHF diagnostic code can successfully

identify individuals with the condition provided both hospitalization and ambulatory care data are used. However, this

TABLE 3
Comparison of congestive heart failure status from manually abstracted primary care physician data and administrative data using nine different algorithms (counts)

Algorithm	Description	CHF definition	True positive, N	False positive, N	True negative, N	False negative, N
1	1 CII record	Narrow	60	31	2208	39
		Broad	60	38	2201	39
2	1 OHIP claim	Narrow	82	95	2144	17
		Broad	82	95	2144	17
3	1 CII or OHIP claim	Narrow	89	145	2094	10
		Broad	90	149	2090	9
4	1 CII or 1 OHIP + 2nd claim (any source) in 1 year	Narrow	84	67	2172	15
		Broad	84	72	2167	15
5	1 CII or 1 OHIP + 2nd claim (any source) in 2 years	Narrow	84	68	2171	15
		Broad	84	73	2166	15
6	1 CII or 1 OHIP + 2nd claim (any source) in 3 years	Narrow	84	69	2170	15
		Broad	84	74	2165	15
7	2 OHIP/ NACRS claims in 1 year	Narrow	72	49	2190	27
		Broad	72	49	2190	27
8	2 OHIP/ NACRS claims in 2 years	Narrow	74	49	2190	25
		Broad	74	49	2190	25
9	2 OHIP/ NACRS claims in 3 years	Narrow	75	50	2189	24
		Broad	75	50	2189	24

Abbreviations: CHF, congestive heart failure; CII, Canadian Institute for Health Information; NACRS, National Ambulatory Care Reporting System; OHIP, Ontario Health Insurance Plan.

results in an unacceptably high number of false positives. It is possible that physicians may code CHF when ruling out CHF and a second diagnostic code would then be necessary to confirm that this is a true case of CHF.

We found the best algorithm for identifying cases of CHF to be one hospitalization record alone or one ambulatory care record if it is followed by a second record from any source within one year; this successfully identifies approximately 85% of patients with CHF, while keeping the false positive rate to the relatively low level of about 3%. This finding is similar to those in studies of other chronic conditions, such as diabetes,⁷ hypertension⁶ and ischemic heart disease,⁸ and in previous validation studies of the use of administrative data to identify CHF cases.^{10,11}

The fact that length of follow up time to the second CHF record made little or no difference was somewhat surprising and differs from the results of similar studies for hypertension and diabetes.^{6,7} The explanation for this may lie with the fact that most people with true CHF are on medication and likely visiting a physician every few months. As a result, one year of follow-up is sufficient for our algorithm to detect CHF cases even if patients are not hospitalized. Hypertension and diabetes, on the other hand, may be initially managed without medication, which may lead to individuals going longer between visits to their physician, which in turn means that a longer follow-up time is required to pick up the second record.

The PPV for all algorithms seem somewhat low, ranging from 37.7 to 65.9. This is due to the fact that PPV is strongly related to prevalence: the lower the prevalence, the lower the PPV. CHF was relatively rare in our population, with a prevalence of only 4.3%; hence the low PPVs.

CHF is strongly age-related: extremely rare among those aged less than 40 years and rare among those aged between 40 and 65 years, it is increasingly prevalent after age 65 years. This prompts us to recommend that the algorithm not be used for populations where CHF is known to be very rare (i.e. among those aged less than 40 years).

The algorithm can be expected to perform very well among the elderly, particularly those aged over 75 years.

With respect to the ICD-9 and ICD-10 codes used to define CHF, we found no evidence that using an expanded list of diagnostic codes performed any better than the narrow definition of ICD-9 428 and ICD-10 I500, I501 and I509.

Limitations

The limitations to this study are mostly related to the fact that much of the data being used were collected for administrative purposes, not for research. A major limitation of the OHIP data is that only one diagnosis code is listed per billing. If CHF is not the patient's main reason for visiting a physician, it may not be recorded. Offsetting this limitation is the fact that Ontarians visit their physicians quite frequently, especially if they are aged over 65 years, thus providing a physician a number of chances to record CHF on a billing during a year. This is evident in the fact that length of follow-up made no difference in the ability of our algorithms to detect CHF cases.

While we recognize that we were unable to apply New York Heart Association (NYHA) diagnostic criteria for CHF to determine the presence of heart failure, our study used "real world" data based on physicians diagnosing and managing patients according to their own diagnostic acumen. While this may or may not fit into formal structured criteria, we would argue that if a physician is treating a patient as having CHF, it is reasonable to consider the patient as having the condition for incidence and prevalence reporting in a large population.

Conclusion

This study has shown that cases of CHF can be identified with a high degree of accuracy from administrative data, provided both ambulatory and hospitalization records are used. An algorithm of one hospitalization record, or one ambulatory record followed by a second record from either source within one year, with a diagnostic code definition of ICD-9 428 and ICD-10 I500, I501, I509, will identify

CHF patients with a sensitivity of 84.8% and a specificity of 97.0%.

Acknowledgements

This study was supported by the Institute for Clinical Evaluative Sciences (ICES), which is funded by an annual grant from the Ontario Ministry of Health and Long-Term Care. The opinions, results and conclusions reported in this paper are those of the authors and are independent from the funding sources. No endorsement by ICES or the Ontario Ministry of Health and Long-Term Care is intended or should be inferred.

Dr. Karen Tu is supported by a Fellowship in Primary Care Research by the Canadian Institutes of Health Research (CIHR).

This study was funded by a grant from the Public Health Agency of Canada and by a Canadian Institutes of Health Research team grant in Cardiovascular Outcomes Research to the Canadian Cardiovascular Outcomes Research Team (CCORT).

Conflict of interest: none.

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Pain and health-related quality of life in people with chronic leg ulcers

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This article has been peer reviewed.

Abstract

Introduction: Venous leg ulceration is associated with pain and poor health-related quality of life (HRQL). The purpose of this study was to identify demographic and clinical characteristics associated with pain and decreased HRQL in patients with active venous ulcers.

Methods: Baseline data were combined from two trials that took place between 2001 and 2007 ($n = 564$). Pain was measured using the Numeric Pain Scale (NPS), and HRQL was measured using the Medical Outcomes Survey 12-item Short Form (SF-12), which generates a Physical (PCS) and Mental Component Summary (MCS). Analyses included logistic and linear regression (for pain and HRQL, respectively).

Results: Mean age was 66.5 years; 47% were male. Median NPS score was 2.2 (out of 10) and mean PCS and MCS scores were 38.0 and 50.5, respectively (scores are standardized to a mean of 50 representing average HRQL). Younger age, living with others, and arthritis were associated with pain. Poorer PCS was associated with being female, venous/mixed ulcer etiology, larger ulcers, longer ulcer duration, cardiovascular disease, arthritis and higher pain intensity. Poorer MCS was associated with younger age, longer ulcer duration, comorbidity and higher pain intensity.

Conclusion: Research is needed to test strategies to reduce pain and possibly improve HRQL in high risk groups.

Keywords: chronic, leg ulcers, SF-12, pain, HRQL, Medical Outcomes Survey 12-item Short Form, health-related quality of life

Introduction

A venous ulcer is a recurrent chronic wound on the lower leg. Venous ulceration mostly occurs among older adults, but onset can be as early as in the patient's twenties.^{1,2} The estimated prevalence of active venous ulcers is 0.8 to 1 per 1000 population.³ Improvements in practice and the organization of care have vastly improved rates of healing.^{4,5} However, even after 12 months of care, 20% will

remain unhealed⁶ and up to 34% will have recurred.^{7,8}

The burden of illness for this population is considerable. Venous ulcers negatively affect mobility, employment, social roles, physical activity and quality of life.⁹⁻¹² Pain is one of the most commonly reported side effects;¹³ a recent integrative review found that pain was the factor most frequently identified as affecting health-related quality of life (HRQL).¹⁴

Ulcer healing, along with HRQL, are of central concern to sufferers and wound care practitioners as these outcomes reflect the impact of chronicity, recurrence and symptom burden.

In considering chronicity and well-being, the Wilson and Cleary¹⁵ conceptualization proposes that HRQL is made up of four health outcomes aligned in a causal pathway and influenced by individual and environmental factors. The health outcomes are biological factors, which affect symptom status, which together affect functional status. The final one is general health perception, which is affected by the three outcomes that precede it in the causal path, and by individual and environmental factors.

Biological factors reflect cell, organ or system functioning and are frequently defined as indicators of disease severity. Within the context of venous leg ulcers, biological factors can include ulcer size, duration and etiology, as well as any comorbid conditions that the patient may have. The evidence is mixed regarding the association between ulcer size or duration and HRQL.^{13,16-18} Comorbidity in venous disease has not been extensively studied, although diabetes, arterial insufficiency and autoimmune diseases are generally thought to delay healing. One study reported that osteoarthritis was associated with ulcer pain.¹⁹

Symptom status is the person's perception of an abnormal physical, emotional or cognitive state. Ulceration is associated

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with numerous symptoms including pain, wound drainage, itching, lower limb swelling and odour.²⁰ Of all these symptoms, pain has been the most researched, possibly because there are a number of validated methods for assessing pain.¹⁴ The impact of pain may be immense, causing even young, otherwise able-bodied individuals to seek leaves of absence, sick days, and even early retirement.^{21,22}

In 1995, Wilson and Cleary¹⁵ defined functional status as the ability to perform normal tasks in a minimum of four domains, including physical, social, role and psychological. Venous disease symptoms negatively affect activities of daily living^{9,11,20} and physical function.¹⁰ Mobility may be impaired by swelling,²¹ and symptom burden may also negatively affect mental health.^{21,23} General health perception, a subjective overall rating of health, represents an integration or synthesis of biological factors, symptom status and functional status.¹⁵ For those with venous ulceration, reductions in the domain of general health perception (measured using the Medical Outcomes Short Form-36 Questionnaire) ranged from 3.3 to 13.3, on a scale 0 to 100, when compared with population normative scores.^{24,26}

Individual factors may also influence symptom status, functional status, health perceptions and quality of life. Price and Harding²⁴ did not find a difference between men and women in HRQL, but Lindholm²⁷ and Franks et al.²⁸ found that men experienced a greater impact in more domains of HRQL. Another study found that living with a spouse was associated with improved HRQL.²⁹

The purpose of our study was to explore the relationship between clinical variables, pain and HRQL in patients with active venous ulcers. The Wilson and Cleary¹⁵ model provided the basis for identifying variables of interest in our two primary research questions: (1) do age, gender, living conditions, comorbidity and leg ulcer size and duration affect pain intensity, and (2) do these same variables and pain intensity affect physical and mental HRQL?

Methods

Our sample consisted of individuals with leg ulcers who participated in two randomized controlled trials (RCTs) carried out between 2001 and 2007.^{5,30} Ulcer healing was the primary outcome measure in both trials; HRQL and pain were secondary outcomes. The cross-sectional baseline assessment data from both trials formed the dataset for the current study. The original trials were reviewed for ethical compliance by the Queen's University and Affiliated Teaching Hospitals Research Ethics Board (the Canadian Bandaging Trial³⁰) and the Ottawa Health Research Institute Ethics Board (Nurse Clinic Versus Home Delivery RCT⁵); the current combined analysis was approved by the Queen's University and Affiliated Teaching Hospitals Research Ethics Board.

All trial participants received comprehensive, evidence-based assessments by nurses in homecare settings in several Canadian communities as well as in remote/rural areas. Participants in both studies had to be aged 18 years or older, give consent to participate, not have diabetes and have a venous or mixed-venous arterial ulcer. Further eligibility criteria included having an opening in the skin below the knee at least 0.7 cm in any dimension for at least one week and an ankle brachial pressure index of 0.8 or more. The ulcer was either a first occurrence or a recurrence.

HRQL was measured using the Medical Outcomes Survey 12-item Short Form (SF-12).³¹ The SF-12 produces two scores, the Physical Component Summary (PCS) and the Mental Component Summary (MCS). The PCS is primarily based on the original Medical Outcomes Survey 36-item Short Form (SF-36) domains of physical functioning, role limitations due to physical health problems, bodily pain and general health perception, while the MCS is primarily based on the domains of vitality, social functioning, role limitation due to emotional problems and mental health.³² While the original domains are scored on a scale of 0 to 100, the PCS and MCS are standardized to a mean of 50, with scores above and below 50 representing better than and poorer than average summaries,

respectively.^{31,32} A 2 to 3 point difference is considered clinically meaningful.³¹ The instrument has demonstrated good discriminatory function in numerous health conditions³³ and in two venous leg ulcer samples based on age, ulcer duration and mobility¹⁷ and healed status at 12 months.¹⁶ Numerous leg ulcer studies have used this instrument to measure HRQL or quality of life.^{4,16,17,19,24,26,30,34,35}

Pain was measured using two scales, the Numeric Pain Scale (NPS) and the Present Pain Intensity (PPI). The NPS ranges from zero ("no pain") and 10 ("most pain"). The median NPS score ($\leq 2.2/10$ vs. $> 2.2/10$) differentiated a lower pain group from a higher pain group. The PPI consists of six number-word combinations ranging from zero ("no pain") to five ("excruciating pain"). The PPI is part of the short form McGill Pain Questionnaire,³⁶ and both the NPS and PPI have been used in diverse clinical populations including those with venous ulcers.^{16,19,37,39}

Biological variables included ulcer size, duration and etiology, as well as comorbid conditions. The ulcer area was measured using computer planimetry of ulcer tracings and categorized as either equal or less than 5 cm² or greater than 5 cm². The duration of the ulcer was based on patient report and categorized as either equal or less than 6 months or greater than 6 months. Ulcer etiology and comorbid conditions were collected using the Leg Ulcer Assessment Tool.⁴⁰ Patients identified relevant comorbid conditions from a list associated with different ulcer etiologies, such as heart disease, hypertension, renal disease, lower limb arterial disease and inflammatory bowel disease. Individual characteristics were defined as age (categorized as less than versus equal or more than 65 years), gender and social support (living alone or with others).

Using chi-square tests, we assessed the association between categorical variables and the two-level NPS pain measure, while Student's *t*-tests were used to assess the association between these variables and the two continuous HRQL measures. Multivariable logistic (pain) and linear (HRQL) regression was then used to identify the subset of significant factors

associated with the three outcomes. Gender was forced into the regression models in light of preliminary evidence that HRQL scores differed between men and women with leg ulcers. All regression procedures used simultaneous entry. Variables were eliminated one at a time in successive regressions if p was over .10 and retained if p less than or equal to .10 so as not to miss clinically important trends. Odds ratios (ORs) and 95% confidence intervals (CIs) are reported for the final multivariable models. Analyses were conducted using SPSS version 19.0 for windows (IBM, Chicago, IL, US).

Results

The sociodemographic and clinical profile of the 564 study participants is fairly typical of the population with leg ulcers (Table 1). Age ranged from 23 to 95 years, with a mean of 66.5 years and a standard deviation (SD) of 15.9; 340 (60.3%) were over 65 years. There were more men in the younger group (< 65 years; 127/224, 57%) and more women in the older group (≥ 65 years; 201/340, 59%) but the overall gender distribution was similar. Ulcers were predominantly due to venous disease (488/564, 86.5%) involving one leg. The median ulcer size was 3.4 cm^2 and the median duration was 2.6 months. Approximately 60% had at least one comorbid condition, with arthritis being the most common (211/564, 37.4%). One-fifth of respondents (114/564; 20.2%) reported no pain and 17.6% (99/564) reported pain that was "distressing" or worse (Table 2). The mean PCS was 38.0, well below the Canadian normative population mean of 50.5, but the mean MCS was 50.5, similar to the population normative score of 51.7.⁴¹

Living with others ($p = .014$), presence of comorbidities ($p = .031$) and arthritis ($p = .009$) were associated with pain of more than 2.2/10 in bivariable analysis (Table 3). The final logistic regression model explained only 4% of the variance in pain intensity. In the multivariable model, living with others (OR = 1.5, 95% CI: 1.1–2.1, $p = .023$) and arthritis (OR = 1.6, 95% CI: 1.1–2.2, $p = .016$) were independently associated with pain. Being older (OR = 0.7, 95% CI: 0.5–1.0,

TABLE 1
Characteristics of study sample with chronic leg ulcers ($n = 564$)

Characteristic	
Male, n (%)	266 (47.2)
Age, years	
Mean (SD)	66.5 (15.9)
Median	69.0
Range	23–95
> 65 years, n (%)	340 (60.3)
Living alone, n (%)	203 (36.0)
Current smoker, n (%)	75 (13.3)
Presence of comorbidity ^a , n (%)	346 (61.3)
Arthritis	211 (37.4)
Cardiovascular disease ^b	134 (23.8)
Hypertension	183 (32.4)
Renal disease	28 (5.0)
Probable etiology, n (%)	
Venous	488 (86.5)
Venous-mixed	76 (13.5)
Bilateral ulcers, n (%)	21 (3.7)
Ulcer size	
Mean	9.98
Median	3.41
Range	1–270
$> 5.0 \text{ cm}^2$, n (%)	221 (39.2)
Ulcer duration, months	
Mean	8.7
Median	2.6
Range	0.03–243.8
> 6 months, n (%)	292 (51.8)

Abbreviation: SD, standard deviation.

^a Vasculitis, inflammatory bowel disease, arthritis, cardiovascular disease, hypertension, diabetes, renal disease.

^b Cerebral vascular accident, transient ischemic attack, lower extremity arterial disease, myocardial infarction, angina, congestive heart failure.

$p = .052$) was also associated with pain but fell just short of statistical significance. Being male was associated with less pain but this was nonsignificant ($p = .29$).

Bivariable tests for the PCS (Table 4) show that poorer physically related HRQL was significantly associated with several factors: older age ($p = .037$), venous-mixed etiology ($p < .001$), presence of comorbidities ($p < .001$), cardiovascular disease ($p = .002$), arthritis ($p < .001$), hypertension ($p = .027$) and an NPS score higher than 2.2 ($p < .001$).

TABLE 2
Pain intensity and health-related quality of life characteristics for study sample with chronic leg ulcers ($n = 564$)

Outcome	
NPS ^a	
Mean	2.9
Median	2.2
Range	0–10
NPS categorized at the median, n (%)	
≤ 2.2	287 (50.9)
> 2.2	277 (49.1)
PPI ^b , n (%)	
No pain	114 (20.2)
Mild	157 (27.8)
Discomforting pain	194 (34.4)
Distressing	53 (9.4)
Horrible	25 (4.4)
Excruciating	21 (3.7)
PCS ^c	
Mean	38.0
Median	37.9
Range	11.6–65.0
MCS ^d	
Mean	50.5
Median	52.3
Range	20.5–69.3

Abbreviations: HRQL, health-related quality of life; MCS, Mental Component Summary; NPS, Numeric Pain Scale; PCS, Physical Component Summary; PPI, Present Pain Index.

^a The NPS ranges from zero ("no pain") to 10 ("most pain"). The median NPS score ($< 2.2/10$ vs. $> 2.2/10$) differentiated a lower pain group from a higher pain group.

^b The PPI consists of six number-word combinations ranging from 0 ("no pain") to 5 ("excruciating pain").

^c Physical Component Summary of the Medical Outcomes Survey 12-item Short Form (SF-12),⁴¹ centred to 50 with scores over 50 and under 50 representing better than and poorer than average scores respectively, range 8–73.

^d Mental Component Summary of the Medical Outcomes Survey 12-item Short Form (SF-12),⁴¹ centred to 50 with scores over 50 and under 50 representing better than and poorer than average scores respectively, range 9–74.

The coefficients and the associated 95% CIs for the final regression model are also shown in Table 4. The model explained 10.5% of the variability in outcome. Arthritis and an NPS score higher than 2.2 were both independently associated with a poorer PCS ($p < .001$ for both), as were mixed etiology ($p = .002$) and longer ulcer duration ($p = .006$). Cardiovascular

TABLE 3
Bivariable associations for pain intensity and final logistic regression model

Variable ^a	Bivariable associations (χ^2 tests)			Final regression model ^b	
	0-2.2 ^c n (%)	2.3-10 ^c n (%)	p value	OR (95% CI)	p value
Sex					
Female (0)	145 (48.7)	153 (51.3)	.30	1.0	.29 ^d
Male (1)	142 (53.0)	125 (47.0)		0.83 (0.6, 1.2)	
Age					
< 65 years (0)	104 (46.4)	120 (53.6)	.10	1.0	.052 ^d
> 65 years (1)	182 (53.5)	158 (46.5)		0.71 (0.5, 1.0)	
Social support					
Lives alone (0)	117 (57.6)	86 (42.4)	.014	1.0	.023
Lives with others (1)	169 (46.8)	192 (53.2)		1.5 (1.1, 2.1)	
Smoking status					
Current smoker	34 (45.3)	41 (54.7)	.32		
Non-smoker	252 (51.5)	237 (48.5)			
Ulcer size					
< 5 cm ²	163 (47.9)	177 (52.1)	.09		
> 5 cm ²	123 (55.2)	100 (44.8)			
Ulcer duration					
< 6 months	200 (48.7)	211 (51.3)	.11		
> 6 months	86 (56.2)	67 (43.8)			
Etiology					
Venous	251 (51.4)	237 (48.6)	.38		
Venous-mixed	35 (46.1)	41 (53.9)			
Presence of comorbidity					
Yes	163 (47.1)	183 (52.9)	.031		
No	123 (56.4)	95 (43.6)			
Cardiovascular comorbidities					
Yes	61 (45.5)	73 (54.5)	.20		
No	225 (52.3)	205 (47.7)			
Arthritis					
Yes (1)	92 (32.2)	119 (42.8)	.009	1.6 (1.1, 2.2)	.016
No (0)	194 (67.8)	159 (57.2)		1.0	
Hypertension					
Yes	97 (53)	86 (47)	.45		
No	189 (49.6)	192 (50.4)			

Abbreviations: CI, confidence interval; NPS, Numeric Pain Scale; OR, odds ratio.

^a Values in parentheses represent the variable coding for the linear regression model. Sex was forced into the model.

^b r^2 Cox & Snell for multivariable model = 0.04.

^c The NPS ranges from zero ("no pain") to ten ("most pain"). The median NPS score (< 2.2/10 vs. >2.2/10) differentiated a lower pain group from a higher pain group.

^d Not statistically significant but of interest empirically (sex) or clinically important (age) and therefore retained in the model.

comorbidity ($p = .058$) and a larger ulcer size ($p = .09$) were also associated with a lower PCS. While they fell short of statistical significance, they were deemed clinically important and therefore retained in the model.

Further, the results of bivariable and multivariable tests for the MCS (Table 5) reveal that those aged over 65 years report a better MCS compared with those aged under 65 years ($p = .006$), while those with higher pain intensity reported a poorer MCS

($p < .001$). Sex was not significant ($p = .6$). Only one additional variable, presence of comorbidity, showed a trend towards a poorer MCS ($p = .058$). The coefficients and the associated 95% CIs for the final regression model are also shown in Table 5. The model explained 7.8% of the variability in outcome. Older age was associated with a better MCS ($p = .005$), while presence of comorbidity and higher pain intensity were both associated with a poorer MCS ($p = .014$ and $p < .001$ respectively). Longer ulcer duration ($p = .053$) was also associated with a poorer MCS; while it fell short of statistical significance, it was considered clinically important and retained in the model.

Discussion

To our knowledge, this is one of the largest studies to explore the relationships between routinely measured clinical variables and HRQL in a clinically validated venous ulcer population. We found substantial support for the associations between individual, environmental and clinical variables, pain and HRQL in this population.

Women tended to report somewhat higher pain and poorer PCS and MCS scores, but the results were not statistically significant in any of the three models. Younger participants tended to report more pain and a poorer MCS, but age was just short of being significant in the final regression model of the PCS. The PCS is known to decline with age,⁴⁰ and we therefore anticipated a relatively poor PCS in the older adult group. The large sample size ensured a good representation of younger and older adults, and the lack of effect is therefore not due to homogeneity of the independent variable. One explanation is that the younger group had poorer PCS scores than expected and therefore nullified the effect of age. This would lend support to earlier findings that those younger than 65 years had a greater deviation from HRQL norms than those who are older,²⁸ which is supported by the fact that the mean PCS for both groups was well below the Canadian normative value.⁴⁰ It is also possible that there was collinearity with some of the other variables such as arthritis, which was far more common in the older age group. However,

TABLE 4
Bivariable associations for the SF-12 Physical Component Summary and final multivariable linear regression model

Variable ^a	Bivariable associations ^b		Final regression model	
	Mean (SD)	p value	Coefficient (95% CI)	p value
Constant for model			42.8 (41.0, 44.6)	
Sex				
Female (0)	37.3 (9.7)	.077	1.1 (–0.5, 2.8)	.18
Male (1)	38.9 (10.7)			
Age				
< 65 years	39.1 (9.9)	.037		
> 65 years	37.3 (10.4)			
Smoking status				
Current smoker	39.3 (10.3)	.25		
Non-smoker	37.5 (10.2)			
Social support				
Lives alone	37.5 (10.2)	.34		
Lives with others	38.4 (10.2)			
Ulcer size				
≤ 5 cm ² (0)	38.6 (10.8)	.10	–1.4 (–3.1, 0.2)	.09 ^c
> 5 cm ² (1)	37.2 (9.1)			
Ulcer duration				
≤ 6 months (0)	38.5 (11.1)	.09	–2.6 (–4.5, –0.7)	.006
> 6 months (1)	36.9 (9.3)			
Leg ulcer etiology				
Venous (0)	38.7 (10.2)	< .001	–3.9 (–6.4, –1.5)	.002
Venous-mixed (1)	33.6 (9.2)			
Presence of comorbidity				
Yes	36.5 (10.5)	< .001		
No	40.5 (9.2)			
Cardiovascular disease				
Yes (1)	35.4 (11.0)	.002	–2.0 (–3.9, 0.1)	.058 ^c
No (0)	38.9 (9.7)			
Arthritis				
Yes (1)	35.3 (10.5)	< .001	–3.4 (–5.1, –1.6)	< .001
No (0)	39.7 (9.7)			
Hypertension				
Yes	36.7 (9.8)	.027		
No	38.7 (10.3)			
Pain ^d				
≤ 2.2 (0)	39.9 (9.7)	< .001	–3.5 (–5.1, –1.9)	< .001
> 2.2 (1)	36.1 (10.2)			

Abbreviations: CI, confidence interval; NPS, Numeric Pain Scale; R², coefficient of determination; SD, standard deviation; SF-12, Medical Outcomes Survey 12-Item Short Form.

^a Values in parentheses represent the variable coding for the linear regression model. Sex was forced into the model. Adjusted R² for the model = .11

^b Results of Student's *t*-tests.

^c Not statistically significant but of interest empirically (sex) or clinically important (size, cardiovascular disease) and therefore retained in the model.

^d Based on the median NPS score differentiating a lower pain group (< 2.2/10) from a higher pain group (> 2.2/10).

taking out individual variables and rerunning the models had little effect on the other regression coefficients, suggesting that collinearity was minimal.

Younger age was associated with higher pain scores, despite the probable increase in comorbid conditions associated with pain in the older group. There was no statistically significant difference in ulcer characteristics between younger and older adults, therefore a biological basis for a difference in pain intensity is improbable. It is possible that younger adults have higher expectations and are more likely to be active due to work and family than older adults, which may exacerbate pain. Unfortunately, we cannot test this hypothesis due to the lack of a measure of functional status in our study. Another possibility is that older and younger adults experience or report pain intensity differently; however, there is no evidence to support this and much of the literature suggests pain intensity increases with age.⁴² Both the PCS and the MCS were very significantly and negatively associated with a higher pain level, as expected.

Neither size nor duration of ulcer were significantly associated with pain levels in bivariable or multivariable testing, although trends existed for higher levels of pain in smaller ulcers and in those of shorter duration. Studies of the relationship between size or duration of ulcers and pain intensity have been limited. Pieper et al.⁴³ found a moderate correlation between very large wounds and pain intensity (Pearson *r* = 0.44). Walters et al.¹⁶ found an association between venous ulcers larger than 5.6 cm² and a higher daytime pain score in their large cross-sectional study. Our results do not support either of these studies, possibly due to methodological differences. Pieper et al.⁴³ recruited a small number of younger adults with large venous ulcers who also had addiction issues. Moreover, of the four temporal measures of pain, only daytime pain intensity was associated with ulcer size. It may be that the relationship of pain intensity and ulcer characteristics is neither simple nor linear. Clinically, small ulcers associated with perforator vein incompetence or hypopig-

TABLE 5
Bivariable associations (Student's *t*-tests) for the SF-12 Mental Component Summary and final multivariable linear regression model

Variable ^a	Bivariable associations ^b		Final regression model	
	Mean (SD)	<i>p</i> value	Coefficient (95% CI)	<i>p</i> value
Constant for model			53.2 (54.1, 55.5)	
Sex				
Female (0)	50.3 (10.6)	.61	0.4 (- 1.3, 2.1)	.63
Male (1)	50.8 (10.2)			
Age				
< 65 years (0)	49.0 (11.0)	.006	2.6 (0.8, 4.4)	.005
> 65 years (1)	51.5 (9.8)			
Smoking status				
Current smoker	48.8 (11.1)	.12		
Non-smoker	50.8 (10.3)			
Social support				
Lives alone	50.0 (10.6)	.46		
Lives With others	50.3 (10.3)			
Ulcer size				
< 5 cm ²	50.5 (10.4)	.83		
> 5 cm ²	50.7 (10.4)			
Ulcer duration				
< 6 months (0)	50.9 (10.1)	.16	-1.9 (- 3.9, 0.0)	.053 ^c
> 6 months (1)	49.5 (10.6)			
Leg ulcer etiology				
Venous	50.6 (10.5)	.59		
Venous-mixed	50.0 (10.0)			
Presence of comorbidity				
Yes (1)	50.0 (10.8)	.058	-2.3 (- 4.2, - 0.5)	.014
No (0)	51.4 (9.7)			
Cardiovascular disease				
Yes	50.1 (10.6)	.78		
No	50.7 (10.3)			
Arthritis				
Yes	50.3 (10.8)	.26		
No	50.7 (10.1)			
Hypertension				
Yes	51.0 (10.2)	.56		
No	50.3 (10.4)			
Pain ^d				
≤ 2.2 (0)	53.1 (9.5)	< .001	-4.9 (- 5.6, - 3.2)	< .001

Abbreviations: CI, confidence interval; NPS, Numeric Pain Scale; *R*², coefficient of determination; SD, standard deviation; SF-12, Medical Outcomes Survey 12-item Short Form.

^a Values in parentheses represent the variable coding for the linear regression model. Sex was forced into the model. Adjusted *R*² for the model = .08.

^b Results of Student's *t*-tests.

^c Not statistically significant but of interest empirically (sex) or clinically important (duration) and therefore retained in the model.

^d Based on the median NPS score differentiating a lower pain group (< 2.2/10) from a higher pain group (> 2.2/10).

mented areas of atrophie blanche may be associated with severe pain,⁴⁴ and older ulcers may be associated with less pain.^{24,45} The relationship between ulcer characteristics, disease severity and pain merits further research.

The final regression models only accounted for a small proportion of the variance in pain intensity and HRQL. This may be due to several factors. One is that the causal associations in the Wilson and Cleary¹⁵ model pathway are weak, but it is more likely that the measures of biological characteristics and symptom status were incomplete and represent a subset of a much larger group. The best way to conceptualize biological characteristics is unclear.⁴⁶ Ulcer size and duration are clinically well-accepted proxies of ulcer severity but the list from which the patients identified their comorbidities, originally designed to aid in the process of differential diagnosis, may have poorly reflected the severity of comorbidity, a potentially important measure in this predominantly older population. In addition, we selected pain intensity, only one indicator of the range of symptoms associated with ulcers. Further, the NPS may not capture salient aspects of the pain experience, such as the affective experience of pain and pain-related interference. A third possibility is that a number of variables that contribute to HRQL, for example, functional status, were not measured within the scope of these two trials. Certainly, there is ample evidence that physical function is impaired during active ulceration. The inclusion of a robust measure of functional status may have increased the explanatory power of these models.

Although the explained variance of the models was limited, we found clinically important relationships between sociodemographic and biological characteristics, pain intensity and HRQL. A clinical scenario commonly found in many nurses' caseloads best illustrates this: Consider an individual who is 67 years old and has had a venous ulcer for 8 months. Osteoarthritis complicates their pain experience, and they rate their pain as 4 on a scale of 0 to 10. Based on these characteristics and the coefficients from the regression model,

we calculate a 14.7-point reduction in physical HRQL and a 7.6-point reduction in mental HRQL. This reduction in HRQL score is clinically important and illustrates the important linkages between routinely measured clinical characteristics and HRQL.

Strengths and limitations

Our study had several limitations. First, causation cannot be tested using a cross-sectional design. Secondly, as a secondary analysis, the study variables were designed to answer different questions. For example, symptom status may have been more effectively measured using a validated disease-specific symptom-based tool in addition to pain intensity. Other important concepts such as functional status were not included.

Strengths of the study include the large sample size and use of validated tools to measure pain and HRQL. In addition, the primary RCTs upon which this analysis is based used consistent and validated approaches to evaluate ulcer size and duration. Finally, the large sample from both urban and rural settings is likely to be reasonably representative of clinical populations receiving treatment for venous ulcers.

Future research should define or test existing disease-specific measures of symptom status as a next step in the development of a clinically relevant model of HRQL. In addition, key concepts such as comorbidity and disease severity need further conceptualization. Finally, age is an important variable to explore in future studies with a robust measure of functional status. Impairment of physical function and other aspects of functional status in relation to age-normative expectations may play a key role in mediating the effect of age and pain on HRQL.

The assessment of HRQL is complex. It is likely that ulcer characteristics and pain intensity, two variables that clinicians frequently measure, account for a limited proportion of HRQL. Both variables are insufficient assessment parameters of HRQL in isolation. As a starting point, the impact of ulceration on daily life is an important topic to discuss with patients

and should be incorporated into assessments and care planning. Understanding the impact of symptoms on function may be critically important in prioritizing goals and patient-centred evaluation of interventions.

Acknowledgements

The Nurse Clinic Versus Home Delivery of Evidence-based Community Leg Ulcer Care RCT was funded by a grant from the Medical Research Council (#MOP-42497), now the Canadian Institutes of Health Research. The Canadian Bandaging Trial was funded by a grant from the Canadian Institutes of Health Research (CIHR #63175, CIHR funded trials ISRCTN37782978).

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Injuries related to consumer products in Canada—a systematic literature review

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This article has been peer reviewed.

Abstract

Objectives: To conduct a systematic literature review of injury related to certain consumer products.

Methods: Forty-six empirical research reports along with 32 surveillance reports from the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) were examined to determine the approximate number of injuries associated with a given product per year and any trends in frequency. Percentages of injuries that: (1) resulted in hospitalization, (2) appeared to result from the product itself and (3) were associated with risky or inappropriate use and/or non-use of a helmet were also extracted from the reports.

Results: Outdoor play and sports equipment appear to be associated with the greatest numbers of injuries. A relatively high proportion of injuries appear to result from inappropriate or risky use of a product and/or inadequate safety precautions.

Conclusion: This review identified the following areas of concern regarding consumer products and injuries: lack of helmet use by people using in-line skates, sleds, snowboards, downhill skis and personal-powered watercraft; operation of all-terrain vehicles (ATVs) and snowmobiles by alcohol-impaired people; operation of snowmobiles at excessive speeds; poor design of playground equipment; and unsafe storage and use of matches.

Introduction

Consumer product safety has been identified as an injury prevention priority in Canada.¹ Data from the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP)^{2,*} indicate that almost half of injuries in children and youth (aged 19 years and less) are related to consumer products.³

At least four broad categories of factors influence injury associated with consumer products:

- (1) The quality of the product and its potential to cause injury by defects or characteristics such as sharp edges, faulty workmanship, poor assembly and product failure;
- (2) Factors related to how the product is used, for example, with too much force or speed, for an inappropriate purpose, or carelessly;
- (3) The element of chance whereby a sound product is used appropriately but an accident that possibly could not have been predicted or prevented occurs; and

- (4) Non-use of protective gear that could prevent or reduce the severity of injury in some instances.

This paper presents the results from a systematic review of the literature on the topic of injury related to consumer products in Canada. It examines, by product, what proportion of injuries may have resulted from a fault in the product itself or from inappropriate or risky use; what proportion of injured people were not using a helmet (where appropriate) when injured; the frequency and severity of injury by product; and any reported frequency trends.

Methods

Definitions of consumer product and injury

According to the *Canada Consumer Product Safety Act* (CCPSA), a consumer product is

“a product, including its components, parts or accessories, that may reasonably be expected to be obtained by an individual to be used for non-commercial purposes, including for domestic, recreational and sports purposes, and includes its packaging.”^{1,4, section 2}

Excluded from this definition are firearms, ammunition and explosives, cross-bows, food and drugs, pest control products, feeds, fertilizers, plants, seeds, controlled substances, aeronautical products, animals,

* CHIRPP is a computerized information system that collects and analyzes data on injuries to people seen at the emergency rooms of 10 pediatric and 4 general hospitals in Canada. More than 80% of the over 1.5 million records concern children and youth aged 19 years and younger.² CHIRPP data are hospital based and therefore only contain information about injuries in those who presented to hospital.

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tobacco and tobacco products, boats and vehicles within the meaning of section 2 of the *Motor Vehicle Safety Act* (MVSA) (i.e. "any vehicle that is capable of being driven or drawn on roads by any means other than muscular power exclusively...").⁵, section 2. However, even though they technically fall under the MVSA, off-road recreational powered vehicles, such as all-terrain vehicles (ATVs), snowmobiles and powered scooters, have been included in this review. Injuries in team sports that use equipment, such as soccer, hockey or baseball, were excluded from this review because they are fairly discrete categories that merit separate reviews, as were injuries resulting from poisonings. Finally, we did include playground equipment because, although not strictly domestic, Health Canada includes it among consumer products.⁶

The definition of injury was problematic in that the CCPSA does not define it. However, in the context of this review, injury implies *International Classification of Diseases, 10th Revision* (ICD-10)⁷ External Cause of Injury codes for unintentional injuries V01–X59, Y85–Y86, excluding motor vehicle traffic injuries occurring on a public highway or street where the injured person is an occupant, poisonings, complications of medical and surgical care, self-inflicted injuries and injuries due to assault, undetermined intent and legal intervention/war. It includes injuries to the head, neck, thorax, abdomen, lower back, lumbar spine, pelvis, shoulder and upper arm, elbow and forearm, wrist and hand, hip and thigh, knee and lower leg, ankle and foot (ICD-10 site codes S00–S99), and multiple body regions, unspecified parts of trunk, limb or body region, effects of foreign body entering through natural orifice, burns and corrosions (ICD-10 codes T00–T32). Because the majority of articles did not define injury, nor cite ICD codes, this systematic literature review relies on the definition of injury as described by the authors of the included material. All injuries were attended by a medical professional, most often in a hospital emergency department.

Systematic literature review search strategy

We searched seven databases covering allied health, clinical medicine, nursing

and health policy (CINAHL Plus, EMBASE, MEDLINE); general science (Web of Science); public health (Global Health); social science (Social Policy & Practice), and applied life sciences (CAB Abstracts). The search took place in February 2011 and included literature published over the last 20 years.

The search terms were: Canad* + (injur* or accident*) + (consumer* or product*). As a convenient crosscheck for the thoroughness of this search, we examined the much larger number of results from an earlier search for a separate project on risk factors related to injury, conducted in July 2010. The risk factor search terms were Canad* + (injur* or accident*) + (risk factor or incident* or caus* or hospital* or mortality or disability* or fall*). This larger search did not identify any additional research on consumer-product-related injury.

We also considered various additional sources including books, book chapters, electronic articles and reports. Three important sources published by the Public Health Agency of Canada (PHAC) were *Child and Youth Injury in Review, 2009 Edition – Spotlight on Consumer Product Safety*;⁸ *CHIRPP Injury Reports/Briefs/Data Samplers*;⁹ and *Inventory of Injury Data Sources and Surveillance Activities*.⁹ Reference lists were examined for pertinent articles missed by the search strategy. Articles were retrieved in both official languages.

Inclusion and exclusion criteria

We included reports of empirical research in Canada that examined injury associated with a consumer product and provided some numerical estimate of importance but excluded commentaries and editorials. Review articles were used as a source of additional references that may have been missed in the initial search, but were not included with the empirical material.

Indices for identifying risk management priorities

After examining all the research retrieved, we selected six indices to assist in identifying priorities for injury reduction. These

were (1) approximate annual number of injuries (estimated by dividing the number of injuries reported by the time period covered); (2) relative severity of the injury expressed in terms of percentage of injured people admitted to hospital; (3) reported trends; (4) proportion of injuries caused by the product itself (e.g. defects); (5) proportion of injuries caused by inappropriate or risky use (CHIRPP records circumstances surrounding the injury, e.g. excessive speed or jumping off the top bunk); and (6) the proportion of injured people who were not using a helmet at the time of the injury (where helmet use is considered appropriate, and where recorded). We highlighted for consideration as priorities those consumer products associated with about 500 or more injuries annually, 20% or more of injured people admitted to hospital, an increasing trend, 5% or more of injuries attributable to the product itself, 50% or more of injured people using the product inappropriately or recklessly, and 50% or more of injured people who were not using a helmet. Cut points on the indices were chosen arbitrarily to identify between five and ten consumer products each. Consumer products for which injuries were either the most numerous or more serious and which met at least one of the four remaining criteria were selected for consideration as priorities for risk management.

Results

The database search located 703 records after removal of duplicates. Of these, 46 reports met our inclusion criteria of original quantitative empirical research (Table 1). Within the resource and time constraints for this project, full articles were obtained for 37 of these. We used information in the abstract for the remaining nine reports. Abstract-only articles were retained in order to avoid any bias associated with using only references for which the whole article could be obtained and also to enable further attempts to locate the full article. In addition, 32 online reports from CHIRPP were retrieved from the Internet using the same search terms and augmented the data retrieved from the literature database search.

TABLE 1
Selected characteristics of injuries associated with consumer products

Product, years, age group studied and reference	Approximate number of injuries per year ^a , n	Percentage of injured people admitted to hospital, %	Age group most affected	Most common type/site of injury (percentage of all injuries from that product)	Trend
Stroller 1990–October 2002, ages 0–23 months ²⁷	140	4.1	0–5 mo	Head, face (78%)	
Infant swing 1990–September 1995, ages < 18 months ²⁸	9	6.0	3–5 mo	Head (87%)	
Car seat 1994–2000, ages < 12 months, Kingston ²⁹			3–5 mo	Head (40%)	
Baby walker 1990–early 2003, ages 5–14 months ^{1,30}	158	8.1	7–10 mo	Head, face (89%)	↓
1994–2000, ages < 12 months, Kingston ²⁹			6–8 mo	Head (50%)	
November 1990–January 1991, NB, PEI, NS ¹¹			5–10 mo		
Bath seat 1990–2005, ages < 24 months ¹	<1	5.0	6–9 mo		↑
Baby gate 1990–October 2002, ages 0–5 years ³²	75	3.6	9–11 mo	Head, face, neck (75%)	
Playpen 1990–October 2002, ages 0–5 years ³³	29	4.9	9–11 mo	Head, face, neck (45%)	
Gas fireplace 1990–2002, Toronto ³⁴		30.0	Median 14 mo	Hand(s) (92%)	
Bassinet, cradle crib 1990–January 1996, ages < 5 years ³⁵	155	5.4	< 2 y	Head, neck (66%)	
Magnet 1993–2007, ages 13 years and under ¹	22	2.7	2–4 y	Ingestion (54.3%)	↑
1993–2003, ages < 13 years ³⁶	16–17	3.9	0–4 y	Foreign body (82.8%)	↑
Television 1990–2007, ages 0–19 years ¹	195	< 4.1	Median 2.8 y		
1990–2002, Halifax, children ³⁷			2–4 y	Head and neck (47%)	
Motorized ride-on toy 1990–2003, ages 1–9 years ³⁸	2–3	9.1	2–4 y	Head and face (45.4%)	
Blind or drapery cord 1990–2003 ¹	1–2	52.9	3–5 y		
Bunk bed top bunk 2002–2006, all ages ¹	187	10.8	3–5 y	Upper extremity (39%)	↓
1999–2001, all ages ³⁹	238	9.4	4–5 y		
Playground equipment 2000, ages 0–14 years ⁴⁰	4225	7.6	5–9 y	Fracture (43%)	
1995–2002, Toronto, fractures ⁴¹		29.0	5–9 y	Upper extremity (85% of fractures)	
Summers 1991 and 1995, Montreal ⁴²			5–9 y		
1995–1996, Toronto, severe injuries ⁴¹		21.4	Mean 6.5 y	Fracture (47.6%) Upper extremity (47.6%)	
1995, ages 1–16, Kingston ⁴⁴			Mean 8.3 y	Extremities (55.6%) Fracture (35.6%)	
Wheeled shoes 2000–2006, all ages ⁴⁵	19	2.9	5–14 y	Upper extremity (61.8%)	↑
1990–2007, all ages ⁴⁶	12	2.9	Median 9.8 y		↑
June 2005–June 2007, Calgary children ⁴⁷		0.0	6–14 y	Upper extremity (76.7%)	
Trampoline 1999–2003, all ages ^{1,48,b}	541	12.4	5–14 y median 10.1 y	Lower (39.8) and upper (39.4) limb fracture	↑
January 1996–October 1997, Winnipeg, children, orthopedic injury ⁴⁹			2–15 y		
Unpowered scooter 1990–May 2001, all ages ⁵⁰	27	4.6	8–13 y	Upper extremity (33.9%)	
1990–2007, all ages ⁴⁶	236	7.3	Median 10.1 y		
1999–2003, ages ≥ 1 year ^{48,b}	273	6.2			

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TABLE 1 (continued)
Selected characteristics of injuries associated with consumer products

Product, years, age group studied and reference	Approximate number of injuries per year ^a , n	Percentage of injured people admitted to hospital, %	Age group most affected	Most common type/site of injury (percentage of all injuries from that product)	Trend
June 2005–June 2007, Calgary children ⁴⁷			6–9 y	Upper extremity (54.3%)	
Swimming pool (drowning or near drowning) 1990–2003, ages 0–14 years ⁵¹	46	57.1	< 4 y		
(entrapments) 1990–2003, all ages ⁵²	2–3	5.7	10–14 y	Foot (5.7%)	
Fireworks, fire crackers and sparklers June 1998–March 2004, all ages ⁵³	16–17	7.4	10–14 y	Upper extremities (46%)	
In-line skates 1998, all ages ⁵⁴	962	7.8	10–14 y	Fracture (47.6%)	
1999–2003, ages > 1 year ^{40,b}	763	7.5			
1990–2007, all ages ⁴⁶	657	6.9	Median 11.9 y		
June 2005–June 2007, Calgary children ⁴⁷			10–14 y	Upper extremity (55.1%)	
Bicycle 2006, ages > 1 year ⁵⁵	3993	11.0	11–15 y	Upper extremity (44.0%)	
1990–2007, all ages ⁴⁶	4726	10.7	Median 11.0 y		
1999–2003, ages > 1 year ^{40,b}	3189	10.2			
1994, ages 0–19, Kingston and area ²⁵			5–14 y		
1994–1998, children ²⁶	2342				
1986–1991, Ontario fatalities ⁵⁶			15–44 y mean 26 y	Head (75%)	
June 2005–June 2009, Calgary children ⁴⁷		5.4	10–14 y	Upper extremity (49.1%)	
1993–2002, Halifax, children < 15 years ⁵⁷		9.6	6–13 y	Shoulder/arm (48.2%)	
Go-cart 2000–2002, ages > 5 years ⁵⁸	45	6.0	10–14 y	Head, face, neck (32.1%) Upper extremity (32.1%)	
1990–2007, all ages ⁵⁹	40	8.2	Median 11.9 y		
Powered scooter 1998–2005, ages > 7 years ⁶⁰	5	15.0	10–19 y	Upper extremity (57.5%)	↑
1990–2007, all ages ⁵⁹	3–4	15.3	Median 12.3 y		
Sled 2000–2002, ages > 5 years ⁶¹	855	9.2	5–14 y	Fracture (37.7%)	
Winter 2001–2002 ⁶²	1027	10.5	5–14 y	Upper (32.3%) and lower (28.0%) extremity and head, face, neck (29.8%)	
1999–2003 ages > 1 year ^{40,b}	759	9.4			
April 1997–March 1999, Edmonton ⁶³		11.0	Median 12 y	Lower (32%) and upper (30%) extremity	
1 December, 1992–24 March, 1993, Sudbury ⁶⁴		7.0	Mean 16 y	Extremity (49%)	
Ice skates 2000–2002, ages > 5 years ⁶¹	866	4.0	5–14 y	Fracture (32.4%)	
1999–2003 ages > 1 year ^{40,b}	760	3.2			
Skateboard 1990–2007, all ages ⁴⁶	755	6.7	Median 13.5 y		
1999–2003 ages > 1 year ^{40,b}	1001	7.3			
June 2005–June 2007, Calgary children ⁴⁷			10–14 y	Upper extremity (53.7%)	
Snowboard 2000–2002, ages > 5 years ⁶¹	1471	11.3	10–14 y	Fracture (57.7%)	
April 2000–March 2001 ⁶⁵	1177	17.2		Upper limb fracture (51.3%)	↑
1999–2003 ages > 1 year ^{40,b}	1262	12.0			
Snowshoes 2000–2002, ages > 5 years ⁶¹	4	0.0	10–14 y	Fracture (38.5%)	
Snowblades 2000–2002, ages > 5 years ⁶¹	35	10.6	10–14 y	Fracture (54.8%)	
Dirt bike 1993–2002, Halifax, children < 15 years ⁵⁷	158	20.0	10–15 y	Shoulder/arm (50.6%)	
1990–2007, all ages ⁵⁹		25.7	Median 14.4 y		↑

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TABLE 1 (continued)
Selected characteristics of injuries associated with consumer products

Product, years, age group studied and reference	Approximate number of injuries per year ^a , n	Percentage of injured people admitted to hospital, %	Age group most affected	Most common type/site of injury (percentage of all injuries from that product)	Trend
Matches 1991–2001, ages < 15 years ⁶⁶	3–4	25.6	13–15 y	Head, face and neck (89%)	
ATVs 1990–2007, all ages ⁶⁹	272	33.6	Median 15 y		↑
1999–2001, all ages ⁶⁷	298	38.4	20–29 y	Lower (30.4%) and upper (30.2%) extremity	
September 1 1998–August 31 2003, London, children ⁶⁸		19.5	8–17 y mean 13.7 y	Fracture (76%)	
1990–1997, Alberta, ages 0–17 ⁶⁹			Median 13 y	Head (44.7%)	
June 1990–December 2002, Halifax children < 16 years, hospital admissions ⁷⁰			13–15 y mean 12 y	Orthopedic (71.7%)	
2002, ages > 15 years, major trauma ⁷¹			16–34 y	Head injury (24%)	
2003–2004, Montreal pediatric hospital admissions ⁷²			3–17 y median 11 y	Brain injury (54%)	
1993–2002, Halifax, children < 15 years ⁵²		30.8	14–15 y	Lower extremity (42.3%)	
Downhill/alpine skis 2000–2002, ages > 5 years ⁶¹	899	12.6	10–14 y	Fracture (41.8%)	
October 1999–September 2000 ⁶⁵	865	16.9		Fracture (41.0%)	
1999–2001 ages > 1 year ^{60,b}	699	12.9			
1991–1992 ski season, Blackcomb, BC ⁷³			7–17 y	Head or face (26.5% of males), knee (30% of females)	
Water tube 1990–2008, all ages ⁷⁴	18	8.7	15–19 y		↑
Water skis 1990–2008, all ages ⁷⁴	35	9.0	15+ y		
Lawnmower 1990–2006, all ages ⁷⁵	69	23.0	20+ y	Lacerations (32%)	
Jet ski/personal-powered watercraft 1990–1997, all ages ⁷⁶	11	28.4	20+ y	Head or neck (33.7%)	
1990–2007, all ages ⁵⁹	16	18.8	Median 20 y		
Cross-country skis 2000–2002, ages > 5 years ⁶¹	34	12.8	20+ y	Fracture (34.3%)	
Annual average in the database as of December 2003 ⁶⁵	37	8.5		Fracture (27.1%)	
Snowmobile 1990–2007, all ages ⁵⁹	215	32.4	Median 22.6 y		
2000–2002, ages > 5 years ⁶¹	223	39.0	20+ y	Fracture (39.3%)	
1985/86–1989/90, Ontario fatalities ⁷¹			Mean 29.9 y		
January 1998–December 1997, Winnipeg, hospital admissions ⁷⁷			19–25 y mean 29.1 y	Musculoskeletal (57%)	
Wheelchair Nova Scotia, all ages ⁷⁸		1.8	21–40 y, mean 44.1 y	Head and neck (50%)	

Abbreviations: ATV, all terrain vehicle; BC, British Columbia; CHIRRP, Canadian Hospitals Injury Reporting and Prevention Program; NB, New Brunswick; NS, Nova Scotia; PEI, Prince Edward Island.

Note: Highlighted items are associated with 500 or more injuries per year, have hospitalization rates of 20% or higher, and injuries are increasing.

^a Data from CHIRRP.

^b Article about trampolines includes comparison with other recreation related equipment.

Table 1 summarizes the results of the systematic literature review by consumer product in terms of estimated annual numbers of injuries, percentage of injured admitted to hospital, most common type/site of injury and any reported trend. The results are ordered approximately by age

group most affected, from youngest to oldest.

From the literature reviewed, in which injuries to children and teenagers predominate, outdoor play and sports equipment appear to be associated with the

greatest numbers of injuries. Playground equipment (e.g. swings, monkey bars, slides, teeter-totters) and bicycles are related to more than 3000 injuries per year each. Downhill winter activities using sleds, snowboards and skis are the next most common at about 1000 injuries per

year each. Other consumer products that are involved with between 500 and 1000 injuries per year are skateboards, in-line skates, ice skates and trampolines.

Consumer products used around the home play a more important role in terms of injury severity than absolute numbers. Injury severity is defined here in terms of the proportion of the injured who are admitted to hospital. Although hospitalization rates can serve as a proxy for severity of injury across consumer products, the fact that CHIRPP data do not include information on people who died without being taken to hospital likely underestimates the severity of some types of consumer product-related injury. Over half of children injured by a blind or drapery cord or in a swimming pool are admitted to hospital, as are 25% to 30% of children burned by gas fireplaces or matches and over 20% of people injured by a lawnmower. Beyond the home, consumer products most likely to be related to serious injury are powered recreational equipment such as ATVs and snowmobiles (over 30% of injured admitted to hospital), personal-powered watercraft and dirt bikes (over 20% admitted to hospital).

Consumer products for which the numbers of injuries may be on the rise include

infant bath seats, trampolines, wheeled shoes, powered scooters, ATVs, dirt bikes, snowboards, water tubes and magnets.

Tables 2 through 4 show the circumstances related to the injury. Because most of the research describing injury circumstances is based on CHIRPP data, consumer products used by children and youth predominate. From the available data, it appears that injuries related to product characteristics are relatively rare (Table 2). Baby swings appear to be the product most often at fault with 12.0% of injuries attributable to the product itself, followed by wheeled shoes (7.6%), powered scooters (7.5%), playground equipment (6.6%), cribs, cradles or bassinets (5.7%), playpens (3.8%), baby gates (3.4%), motorized ride-on toys (3.0%), bunk beds (1.4%) and unpowered scooters (1.0%).

A relatively high proportion of injuries result from inappropriate or risky use of a product (Table 3). For magnets, almost all of the injuries (93.9%) appear to be the result of risky or inappropriate use (e.g. ingestion or insertion in the nose). About three-quarters of injuries from snowmobile accidents can be attributed to alcohol impairment or excessive speed. Alcohol impairment is implicated in just over half of ATV-related injuries. Over 70% of injuries from matches result from inap-

propriate use (e.g. playing with or ingestion). Leaving a child alone in a bath seat is likely the single most common reason for a related injury, accounting for 60.0% of injuries from bath seats. Other injury causes are leaving a baby gate open or not secured (43.4% of injuries), playing, jumping, standing or being pushed from a top bed bunk (40.5%), and lack of a barrier at the top of stairs when a baby is in a walker (24.7%).

The only type of protective gear for which data were available across some products was helmet use. Almost everyone (over 90%) injured while sledding, using wheeled shoes or a personal-powered watercraft were not wearing a helmet (Table 4). Approximately one-half to three-quarters of people injured while downhill skiing, snowboarding, or using an unpowered scooter or in-line skates were not using a helmet. A considerable proportion of those injured while using powered recreational equipment were also not wearing a helmet. For bicycles and ATVs, helmet non-use percentages were available by severity of injury. Almost everyone who was killed in a bicycle-related accident was not wearing a helmet, and for ATV-related injuries, non-use of a helmet occurred in a greater proportion of cases requiring hospital admission or where there was major trauma.

TABLE 2
Proportions of injuries caused by product characteristics

Product	Percentage of injuries caused by product failure, %	Percentage of injuries caused by body entrapment, %	Total percentage of injuries attributable to product characteristics, %
Baby swing	12.0 ⁷⁸		12.0
Wheeled shoes	7.6 ⁴⁵		7.6
Powered scooter	7.5 ⁶⁰		7.5
Playground equipment	2.2 ^{44,a}	4.4 ⁴⁴	6.6
Crib, cradle, bassinet	1.3 ^{35,b}	4.4 ³⁵	5.7
Playpen	2.2 ³³	1.6 ³³	3.8
Baby gate	1.2 ³²	2.2 ³²	3.4
Motorized ride-on toy	3.0 ³⁸		3.0
Bunk bed	1.2 ³⁹	0.2 ³	1.4
Unpowered scooter	1.0 ⁶⁰		1.0
In-line skates	0.5 ⁵⁴		0.5
Bicycle	0.3 ⁵⁵		0.3
Trampoline	0.1 ⁷⁹		0.1

^a Rough edge.

^b Includes 0.3% caused by child eating the wood or being injured by splinters.

TABLE 3
Proportions of injuries caused by inappropriate or risky use of a product

Product	Types of risky or inappropriate use	Percentage of injuries caused by risky or inappropriate use, %
Magnet	Ingestion, insertion in nose or ear	93.9 ³
Snowmobile	Impaired	69.0 ^{23,a} ; 70.0–88.0 ⁷⁷
	Excessive speed	82.0 ⁷⁷
Matches	Playing with or ingesting	71.8 ⁶⁶
Bath seat	Leaving child alone in seat	60.0 ³
All-terrain vehicle	Impaired	≤ 56.0 ^{71,b}
Baby gate	Left open or unsecured	43.4 ³²
Bunk bed (top bunk)	Playing, jumping and standing, being pushed	40.5 ³
Baby walker	Lack of a barrier at the top of stairs	24.7 ³⁰
Bicycle	Impaired or inappropriate use	1.8 ⁵⁵ ; 7.0 ⁵⁶

^a Deaths.

^b Major trauma.

None of the 41 products included in Table 1 was identified by all priority indices, but 26 products were identified by at least one (Table 5). Assuming that priorities are likely to focus on products where injuries are either the most common or the most serious, this table identifies 18 products that fall into one or the other category. The 9 products associated with the most injuries differ from the 9 that result in a higher proportion of hospital admissions. Further selection of products based on at least one other index reduces the prioritized products to 11, that is, 6 that result in a high

number of injuries and 5 that appear to result in more serious injuries requiring hospitalization.

Table 6 highlights consumer products and areas of concern. Of the 6 products associated with a high number of injuries, 4—in-line skates, sleds, snowboards and downhill skis—are associated with a relatively low proportion of helmet use.

Discussion

Systematic literature reviews are prone to both reporting bias (the tendency for

statistically significant results to be reported over results that show no association) and publication bias (the greater likelihood that reports showing statistical significance will be published). This review has attempted to deal with these sources of bias by including both published and unpublished information and articles for which only the abstract was located. A further source of bias can arise from the choice of search terms. Despite every attempt to make this review as comprehensive as possible within the resource constraints, we acknowledge that searching for each individual consumer product (sometimes with different names such as jet ski or personal-powered watercraft) would have been a more exhaustive approach than using the generic term “consumer product,” which some publications may not have used as a keyword.

“Grey literature” (i.e. literature not included in the databases searched) was partially addressed by including online publications (all of which used CHIRPP data); however, the fact that we did not search for government publications in each of the Canadian provinces means that we may have missed some relevant material.^{10 14} We assumed that the national reports using CHIRPP data would have included the data used in provincial reports.

The topic of injury associated with consumer products does not lend itself well to the classical systematic literature review for at least two reasons. First, epidemiological studies often take years to design, carry out, write up and publish in scientific journals; therefore, published epidemiological reports likely will not represent those products where incident reports result in early recalls. Second, a literature review that spans several years may not be relevant to today’s hazards, in that dangerous products may already have been recalled and are no longer available and new products and designs have appeared. For example, missing in the results of this search are potentially harmful effects of personal electronic devices. An example is hearing loss associated with MP3 players.¹⁵

TABLE 4
Non-use of helmets among injured people by product

Consumer product	% of injuries where a helmet was not used
Sled	99.0% ⁶⁴ ; 93% ⁶³
Wheeled shoes	95.4 ⁴⁷ ; 87.3 ⁴⁶
Jet ski/personal-powered watercraft	90.9 ⁵⁹
Skis and snowboard	79.1% ⁸⁰
Skateboard	73.7 ⁴⁷ ; 67.9 ⁴⁶
Unpowered scooter	72.4 ⁵⁰ ; 66.3 ⁴⁷ ; 57.6 ⁴⁶
In-line skates	56.8 ⁴⁷ ; 50.5 ⁵⁴ ; 49.6 ⁴⁶
Snowmobile	43.1 ⁵⁹
Go-cart	39.6 ⁵⁸ ; 17.8 ⁵⁹
Powered scooter	38.9 ⁵⁹
Bicycle	37.3 ⁵⁵ ; 29.8 ⁴⁶ ; 15.4 ⁴⁷ ; 96.0 ^{56,a}
All-terrain vehicle	29.0 ⁵⁹ ; 28.2 ⁶⁷ ; 35.0 ^{68,b} ; 84 ^{71,b} ; 84 ^{72,c} ; 31.7 ^{70,c}
Dirt bike	12.7 ⁵⁹

^a Fatalities.

^b Major trauma.

^c Pediatric hospital admissions.

TABLE 5
Combined priority indices from Tables 1 to 4

Consumer Product	> 500 injuries per year	≥ 20% of injured people hospitalized	Increasing trend	≥ 5% caused by product characteristics	≥ 50% caused by inappropriate or risky use	≥ 50% of injured not using a helmet ^a
Infant swing				✓		
Infant bath seat			✓		✓	
Gas fireplace		✓				
Crib, cradle, bassinet				✓		
Magnet			✓		✓	
Blind or drapery cord		✓				
Playground equipment	✓			✓		
Wheeled shoes			✓	✓		✓
Trampoline	✓		✓			
Unpowered scooter						✓
Swimming pool		✓				
In-line skates	✓					✓
Bicycle	✓					
Powered scooter			✓	✓		
Sled	✓					✓
Ice skates	✓					
Skateboard	✓					
Snowboard	✓		✓			✓
Dirt bike		✓	✓			
Matches		✓			✓	
All-terrain vehicle		✓	✓		✓	
Downhill skis	✓					✓
Water tube			✓			
Lawnmower		✓				
Personal-powered watercraft		✓				✓
Snowmobile		✓			✓	

Note: Highlighted products are those that are most numerous or serious and have values that exceed the cut-point on at least one other priority index.

^a Where helmet use is considered appropriate and where reported.

Since the bulk of CHIRPP data comes from hospitals in cities, and most are pediatric hospitals, injuries suffered by older teen-

agers and adults seen at general hospitals and by First Nations, Métis, Inuit and other people who live in rural and remote

areas are under-represented in the CHIRPP database. In addition, not all provinces and territories have hospitals participating in CHIRPP (e.g. Saskatchewan, New Brunswick, Prince Edward Island, Yukon, Northwest Territories, Nunavut). Fatal injuries are also under-represented because CHIRPP does not capture information about people who died before they could be taken to hospital.² Studies that have assessed the representativeness of CHIRPP data indicate other biases. Sensitivity ranged from 30% to 91% across some hospitals;¹⁶ injuries among older children were more likely to be missed in some hospitals^{17,18} but not others;¹⁶ and more serious injuries (e.g. those admitted to hospital) were less likely

TABLE 6
Consumer products and areas of concern

Issue	Consumer Product
Helmet non-use	In-line skates
	Sleds
	Snowboards
	Downhill skis
	Personal-powered watercraft
Use while impaired	All-terrain vehicles
	Snowmobiles
Excessive speed	Snowmobiles
Product design	Playground equipment (includes surface material)
Inappropriate storage and use	Matches

to be missed in some hospitals^{17,18} and more likely to be missed in others.¹⁶ However, the data collected have been found to be both reliable and valid.¹⁹

Future efforts to look at consumer products and injuries in Canada may wish to focus on the following:

Population attributable risk

One possible approach would involve using the approximate number of injuries per year along with the prevalence of modifiable risk factors (e.g. non-use of helmets) to estimate the population attributable risk reduction of specific interventions. Such an estimate of the potential public health benefit could be used as the basis for setting priorities. However, this approach would likely require a meta-analysis based on a subset of articles with data suitable for pooling and/or the use of raw data from the CHIRPP database.

Exposure-based risk estimates

Although this review identifies those types of products associated with the greatest numbers of injuries, the absolute number of injuries is a function of both the availability of a given product and the risk of injury related to the product. To illustrate, does the fact that there are three to four times as many injuries associated with bicycles as with in-line skates indicate that cycling is riskier, that there are more bicycles than in-line skates or that people spend more time cycling than using in-line skates? Likely, it is a combination of all three factors. With a few exceptions, the studies cited here have not provided estimates of risk of injury relative to exposure to a product, which is necessary to identify particularly hazardous products and their associated activities. The difficulty in providing comparative estimates of risk lies in finding suitable denominators. In the future, for at least some types of consumer products, calculations of injury rates in relation to exposure may be possible. Methods similar to those used by others^{20,23} could be used to relate CHIRPP data to survey data, such as the physical activity of youth and adults collected in the Canadian Health Measures Survey,²⁴ to estimate risk in relation to exposure. Another approach

would be to combine injury data with sales data to give an estimate of risk based on the availability of certain consumer products.

Population-based injury rates

The studies cited here involved different age groups, in different locations and over different time periods, making comparisons of injury rates across products difficult. The CHIRPP database permits the calculation of injury rates in relation to the total number of injuries in the database (overall or for a particular age stratum); however, these rates only approximate population rates, in that people in the CHIRPP database likely do not represent the entire population from which they are drawn. CHIRPP data could be related to Census data to estimate the validity of the former method for estimating population rates (crude and adjusted) and to allow comparisons across products and with other studies where population rates have been used.^{25,26}

Age-specific rates

Although this review was able to identify the age groups most affected by injury related to specific consumer products, it could not identify the products most likely to be associated with injury for specific age groups throughout the lifespan. The CHIRPP dataset could be used to provide this information, which would assist priority-setting and injury reduction strategies in relation to specific age groups.

Conclusions

Despite its acknowledged limitations, this systematic literature review has provided a broad look at the problem of injury related to specific consumer products in Canada in terms of injury frequency, severity, possible trends, and likely causes. The most numerous injuries appear to involve playground equipment and bicycles; the most serious injuries occur around the home or while using powered recreational equipment; injuries related to several consumer products may be increasing; and the most frequent causes of injury appear to be behavioural (i.e. inappropriate or risky use and insufficient safety precautions, such as helmet use), rather than the fault of the product

itself. The analysis presented here identified the following areas of concern regarding consumer products and injuries: (1) lack of helmet use by people using in-line skates, sleds, snowboards, downhill skis and personal-powered watercraft; (2) the operation of ATVs and snowmobiles by people who are impaired by alcohol; (3) the operation of snowmobiles at excessive speeds; (4) poor design of playground equipment; and (5) non-secure storage and use of matches.

Acknowledgements

The authors wish to thank Jane Falconer, Information Services Librarian at the London School of Hygiene & Tropical Medicine, UK, for her invaluable contribution to the design of the literature search strategy.

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Cross-Canada Forum

National Population Health Study of Neurological Conditions in Canada

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Introduction

On June 5, 2009, the federal Minister of Health announced that the Government of Canada was committing \$15 million for a four-year national population health study of neurological conditions (NPHSNC). Designed to improve our understanding of neurological conditions and of their impacts on Canadians, the NPHSNC is being administered by the Public Health Agency of Canada (PHAC) and co-managed by Neurological Health Charities Canada (NHCC), a non-governmental organization representing 25 charities with a focus on neurology. Rather than a single study, the NPHSNC is an extensive research program comprising three national surveys and 13 pan-Canadian research projects, including some studies that look at the feasibility of ongoing surveillance of some neurological conditions and the development of a micro-simulation model. Results will inform future program and policy development. The NPHSNC team is made up of more than 125 researchers at 30 academic and non-academic institutions across Canada.

This paper provides a brief overview of the NPHSNC, summarizes the rationale for the study and presents its history, objectives and approaches.

Background

In 2006, the World Health Organization published *Neurological Disorders: Public Health Challenges*. This book warned of

the societal and health care consequences of the predicted increase in prevalence of neurological and other chronic disorders, coupled with disabilities resulting from the ageing of the global population and increasing life expectancy.¹

In 2007, the Canadian Institute for Health Information, the Canadian Neurological Sciences Federation and the Canadian Brain and Nerve Coalition jointly prepared *The Burden of Neurological Diseases, Disorders and Injuries in Canada*.² This report considered the impact of 11 common neurological conditions in Canada, including Alzheimer disease, amyotrophic lateral sclerosis (ALS), brain tumours, cerebral palsy, epilepsy, head injury, headaches, multiple sclerosis, Parkinson disease, spinal injuries and stroke. The total combined cost of these conditions was "...estimated to be \$8.8 billion, representing 6.7% of the total attributable cost of illness in Canada in 2000–2001."²

History of the NPHSNC

The growing impact of neurological conditions on Canadians and health care systems made it clear that more in-depth information was needed to inform future policy decisions. As a result, in 2008 a number of charitable organizations formed a coalition, NHCC, tasked with working to improve the quality of life of all people living with chronic brain conditions, disorders and injuries, as well as of their caregivers. NHCC does this by elevating brain health to the top of

government agendas and ensuring that research, prevention, treatments and supports for those living with chronic brain conditions are universally accessible.³ NHCC's role is "to provide leadership, evaluating and advancing new opportunities for collaboration specific to advocacy, education and research projects, related to brain health."³

Although the individual member organizations represented by NHCC continued to fund their own psychosocial and/or clinical research projects, the information they gathered could not provide the practical steps necessary to prepare the entire country for the burgeoning population of older adults, in particular those affected by neurological conditions. In June 2008, members of NHCC met with representatives of the Government of Canada to discuss the paucity of epidemiological information on neurological conditions in this country.

In January 2009, PHAC established a Neurological Surveillance Advisory Committee. A nation-wide online survey in February 2009 asked respondents to prioritize research questions across eight themed areas: frequency and progression; access to professional care and services; risk factors; co-existing conditions; impact on individuals; management of the condition; unpaid caregiving; and paid caregiving. Of the 3000 people who responded, 34% identified themselves as living with a neurological condition, 35% as family members or unpaid caregivers, and 31%

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as members of the neurological workforce (service organization staff, health care professionals, researchers, paid caregivers). This input from stakeholders was shared with the approximately 40 neurological researchers at a technical workshop the following month. Hosted jointly by PHAC and NHCC, the purpose of the workshop was to introduce the notion of a national population-based study to the researchers and to prioritize research domains.

With consideration given to the survey results, workshop participants recommended that a study addressing neurological conditions be based on the following five areas of focus:

- the scope of brain conditions, specifically incidence, prevalence and comorbidities;
- the impact of neurological conditions on individuals, their caregivers and families;
- risk factors for onset and prognostic factors;
- best practices and gaps in health services; and
- registries.

In the fall of 2009, a broader group of researchers was formally invited to participate as members of one of five research project teams, later called Expert Advisory Groups. A chair for each group was identified, and in December 2009, a second technical workshop was held. The Expert Advisory Groups, each representing one of the five areas of focus, reorganized them and recommended the types of projects and methodology to be included in the study. "Registries" was subsumed under "scope," leaving four main categories: scope (incidence, prevalence and comorbidities); risk factors; impact; and health services.

Taking into account both the population disease burden and key knowledge gaps, as well as the membership of NHCC at the time, the following priority conditions were chosen: ALS, Alzheimer disease and related dementia, brain tumours, cerebral palsy, dystonia, epilepsy, Huntington disease, hydrocephalus, neurotrauma (including brain and spinal cord injuries), multiple

sclerosis, muscular dystrophy, Parkinson disease, spina bifida, Tourette syndrome, stroke and migraine.

Following this meeting, PHAC and NHCC worked together to finalize the research plan and, in January 2010, PHAC and NHCC issued a call for letters of intent, receiving 42 responses from across Canada. Each letter of intent was reviewed to determine the fit of the proposed work with the needs of the broader study. From these, 12 teams were invited to submit full proposals by April 15, 2010. These projects underwent internal and external scientific review, and 10 were recommended for funding. Identified gaps in the received letters of intent resulted in reissuing the call for proposals in November of that year to further address the registries and health services components of the study through three additional projects.

Thus the NPHSNC was born.

Governance

An Implementation Committee made up of representatives from PHAC, Health Canada, CIHR and NHCC oversees the NPHSNC. A Scientific Advisory Committee provides the Implementation Committee with expert scientific advice and oversees and evaluates the scientific elements of the NPHSNC. Various working groups, made up of NHCC and government representatives and researchers, also contribute to the success of the NPHSNC. Projects that involved participants were reviewed by the Health Canada Research Ethics Board, and approval from the Chief Scientist was received in writing before their initiation.

Categories and projects

Each of the NPHSNC's investigator-driven research projects fall under the aforementioned categories: scope, impact, risk factors and health services.

Scope

The scope category was developed to allow for a review of existing databases, tools and methods and to build capacity for national and patient-driven online registries of neu-

rological conditions. Included projects determined the incidence and prevalence of each of the priority neurological conditions in Canada and worldwide; used health administrative databases to assess co-existing health conditions, health service utilization and economic impact; and validated survey and/or administrative data in use. Other projects created an inventory of existing Canadian and international neurological registries; developed consensus guidelines on registry development and content; prepared a toolkit for the development and implementation of registries; and explored the feasibility of expanding existing registries by, for example, adding new conditions, expanding to other parts of the country, or adding new data.

Impact

Projects that assess the impact of neurological conditions on individuals and on their families and caregivers included a systematic literature review of the biopsychosocial and economic impact of neurological conditions and of the factors that influence the impact of these conditions. In addition, co-existing health conditions, self-management, and health and community services were assessed. Also documented and analyzed were the experiences of people living with neurological conditions both in the community and in institutions across Canada; these included approaches to self-management, challenges and coping strategies, use of and gaps in services, and suggestions for improvements. Lastly, an assessment of the quality of life of Canadians living with neurological conditions determined the influence of personal and community factors (such as accommodations, urban layout, etc.), health services and self-management.

Risk factors

A systematic review of the factors—biological, lifestyle, socio-economic, environmental and psychosocial—that influence the onset, prognostic factors and comorbidities of neurological conditions was conducted. This category also included projects that will add new knowledge on the risk of developing a neurological condition or of prognostic factors.

Best practices and gaps in health services

Projects in this category helped to identify the continuum of care needed for people living with neurological conditions and the best practice models of care that increase quality of life or slow its decline. In addition, an inventory of current health and related services across the country was created and exemplary services and gaps in current practices identified.

Additional NPHSNC components contributing to the "scope" and "impact" categories

Canadian Community Health Survey - Neurological Conditions Module

Pan-Canadian studies of the prevalence of neurological conditions were facilitated by adding questions about these to the 2010/2011 cycles of the Canadian Community Health Survey (CCHS). The aim of the CCHS - Neurological Conditions Module was to collect self-reported prevalence data on specific neurological conditions from individuals with these conditions as well as from other members of the 130 000 Canadian households surveyed. Unique to this module, CCHS methods were expanded on to include all household members, including children under the age of 12 years. The aim of this strategy was to increase the sample size and allow data collection on conditions that present in early childhood.

Survey on Living with Neurological Conditions in Canada (SLNCC)

A follow-up survey of the approximately 4500 individuals who reported neurological conditions in the CCHS Neurological Conditions Module focused on the impact of these conditions on quality of life, particularly family life.

Survey of Neurological Conditions in Institutions in Canada (SNCIC)

The CCHS does not include people living in institutions. Because many people with neurological conditions, particularly in more advanced stages, live in long-term residential care facilities and other institutions, in 2011/2012 Statistics Canada conducted a survey of a representative sample to measure the prevalence of selected neurological conditions in this population.

Expansion of the CCDSS

The PHAC's existing Canadian Chronic Disease Surveillance System (CCDSS), which uses data from provincial/territorial health administrative databases, will include selected neurological conditions. This surveillance system provides information on incidence of new diagnoses, prevalence of these conditions, health outcomes and use of related health services.

Microsimulation

A microsimulation model to project the future burden of priority neurological conditions over the next 5, 10, 15 and 20 years is being developed. This model projects the future incidence and prevalence of these conditions; quality of life of Canadians living with these conditions in terms of disability-adjusted life years and health-adjusted life expectancy (years lived in relative health); life expectancy; and need for, use of and treatment costs of health services.

Next steps

The NPHSNC is in its final year. Over the next several months, as the study's component projects are completed, NHCC and government agencies will undertake a synthesis process to engage stakeholders and disseminate information about the study. This synthesis process will include a meeting of research experts to compile major themes from the research data and significant stakeholder consultation. A "Synthesis Panel" will be struck, comprising experts in epidemiology, health economics, health care evaluation/administration, neurology and medical practice. Its task will be to review the final outputs from the various components and write a summary report. Additional input will be gathered through in-person consultations, online requests for information and feedback from key stakeholder groups. A "Stakeholder Engagement Panel," comprising individuals in the broad community of neurological health charities who have a stake in the success of the NPHSNC and are familiar with one or more of the project focus areas, will then also be struck to review the report on the stakeholder consultations and make recommendations for integrating stakeholder insights in the report on findings. The culmination of all of this work will be a report, to be

submitted to the federal Minister of Health in March 2014.

NPHSNC's knowledge translation and dissemination strategy involves all partners, principal investigators, NHCC and the Government of Canada. Partners will work individually and collectively to ensure that the knowledge generated is disseminated broadly to Canadian stakeholders using a combination of knowledge translation strategies including, but not limited to, peer-reviewed publications, webinars, summary reports and fact sheets.

Conclusion

NPHSNC is collaboration between non-governmental organizations and government that will increase our knowledge about the scope, impact, risk factors and health services related to specific neurological conditions in Canada that can build the foundation for frameworks of intervention.

Acknowledgements

We wish to acknowledge the membership of Neurological Health Charities Canada and the Public Health Agency of Canada for their contribution to the success of this initiative. Additionally, we would like to thank Vidal A. Chavannes of Resolve Research Solutions, Inc., and Jay Onysko, Asako Bienek, Claudia Lagace and Sulan Dai from the Public Health Agency of Canada for their help in editing and reviewing this paper.

Funding for the National Population Health Study of Neurological Conditions was provided by the Public Health Agency of Canada. The opinions expressed in this publication are those of the authors/researchers, and do not necessarily reflect the official views of the Public Health Agency of Canada.

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Status Report

Enhancing the Canadian Best Practices Portal

N. Sims-Jones, MScN (1); E. Dyke, MA (2)

"Minimally, the practice of evidence based public health requires that the right people have the right information at the right time and in the right format."^{1,2}

The mission of the Public Health Agency of Canada (PHAC) is "to promote and protect the health of Canadians through leadership, partnership, innovation and action in public health."² To contribute to this Mission, PHAC has put in place a number of knowledge mobilization initiatives to support evidence-based decision-making in public health settings. One of these, launched in 2006, is the Canadian Best Practices Portal,^{3,4} a searchable database that provides details of effective community level interventions to promote health and prevent chronic diseases: <http://cbpp-pcpe.phac-aspc.gc.ca/>.

The development of the Portal was part of a larger federal initiative, which included the creation of PHAC itself, to strengthen public health capacity in Canada in response to experiences with SARS and the recommendations of the *National Advisory Committee on SARS and Public Health*.⁵ More specifically, the need for a high quality database summarizing current evidence on the effectiveness of population and public health interventions was identified in an earlier report, *Charting the Course: A Pan-Canadian Consultation on Population and Public Health Priorities*.⁶

Other initiatives were also introduced around this time to strengthen public health capacity. In 2005, six National Collaborating Centres for Public Health were established and funded through PHAC. These Centres "produce information to help public health professionals improve their response to public health threats, chronic disease and injury, infec-

tious diseases and health disparities."⁷ They focus on translating evidence produced by academics and researchers so that it can be used by public health practitioners.⁷

Another excellent source of evidence-based information for public health practitioners is Health Evidence.ca, a website that provides access to "methodologically-sound reviews of health promotion and public health interventions."⁸ The ultimate goal of this project is "to facilitate adoption and implementation of effective policies/programs/interventions at the local and regional public health decision making levels across Canada."⁸

Provincial, territorial and municipal governments as well as local health units across Canada have also put in place initiatives to strengthen public health capacity. For example, British Columbia developed a *Framework for Core Functions in Public Health*⁹ to guide the province's public health programs, while Ontario established public health standards "to establish requirements for fundamental public health programs and services."^{10,p1} Quebec has also been active in several areas, including the publication of the *Québec Public Health Program 2003-2012*, which "specifies the public health services that are accessible to all Québec citizens."^{11,p1} In 2010, Nova Scotia produced *Moving Forward: A Commitment to Public Health's Future*,¹² building on the earlier report *The Renewal of Public Health in Nova Scotia: Building a Public Health System to Meet the Needs of Nova Scotians*.¹³ Other provinces and territories have responded in a range of different

ways to increase their public health capacity post-SARS.

Despite the resources available to public health practitioners, ongoing assessments of the Canadian Best Practices Portal indicated that access to a comprehensive listing of information to support planning, implementation and evaluation of public health programs was still a concern. Given this expressed need, PHAC staff began to plan the content for the enhanced Portal, while retaining its original focus on health promotion and chronic disease prevention.

To support identification of additional content, PHAC conducted a review of provincial and, where available, territorial public health legislation and standards. The purpose of this analysis was to identify which areas of health promotion and chronic disease prevention most public health departments across Canada were mandated to address. Not surprisingly, these areas included tobacco control, promotion of physical activity and healthy eating, as well as integrated approaches to chronic disease prevention. Once these topics were identified, relevant information was selected to support program development in each area. This information was found on government websites at the provincial, territorial, federal and international level.

For health promotion programs, and those which address modifiable risk factors, information provided in the "Public Health Topics" section of the enhanced Portal includes surveillance data, strategies, guidance on what works (such as

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guidelines, recommendations and policy approaches) as well as links to relevant systematic reviews of the literature from HealthEvidence.ca and to "Best Practice Interventions" on the Portal itself.

The "Chronic Diseases" section of the enhanced Portal focuses on the prevention of specific chronic diseases. In this section, a broader array of information is provided on risk factors, surveillance, prevention strategies and guidelines, as well as links to key publications, provincial/territorial disease prevention sites, tools and resources, funded projects and relevant systematic reviews of the literature from HealthEvidence.ca.

The "Best Practice Interventions" section provides a link to the searchable database on effective community-level interventions from the original Canadian Best Practices Portal. The revised "Resources" section provides an annotated listing of respected Canadian resources for evidence-informed decision making and planning public health programs.

Health departments are often asked to comment on or develop public health policy for their jurisdictions. The section of the enhanced Portal on policy issues brings together key documents in Canadian and international public health policy, as well as providing links to policy resources and instruments. Finally, the "Learn More" section provides a comprehensive listing of RSS feeds, email updates and listserves from public health agencies and organizations.

Future plans for the enhanced Portal include expanding the range of public health topics and adding other sets of resources to support public health programming, as well as an exploration of local health agency websites. The Canadian Best Practices Portal is an evolving resource and plans are to update it twice a year. If you have any comments or suggestions on content or approach, please contact us at: <http://cbpp-pcpe.phac-aspc.gc.ca/contact-us/>

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